



UNIVERSITÀ DI SIENA 1240

Dipartimento di Economia Politica e Statistica

Dottorato in Economics

XXXVII° Ciclo

Coordinatore: Prof. Simone D'Alessandro

POLICIES TO ELICIT PRO-SOCIAL BEHAVIORS

Settore scientifico disciplinare: *Economia*

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2024/2025

Università degli Studi di Siena

Dottorato in Economia

XXXVII° Ciclo

Data dell'esame finale

19/02/2025

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Abstract

This thesis investigates strategies to elicit pro-social and pro-environmental behaviors, focusing on social norms, economic incentives, and gamification as mechanisms to influence waste management practices or tendency to cooperate. Through three studies, it examines the effects of (1) social norms, illusion of knowledge, and strategic ignorance on recycling behaviors; (2) the Pay-As-You-Throw (PAYT) waste collection system in Tuscan municipalities; and (3) gamification via the game “Prosperia” to foster prosocial actions. Results demonstrate how targeted policies, grounded in behavioral economics, psychology, and public policy, can effectively promote sustainable behaviors. Findings provide insights for policymakers on using diverse mechanisms to optimize environmental and social outcomes.

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Acknowledgments

Those who know me, know how hard this journey has been. I have fully felt the support of all those who have stood by my side during these three years of hard work and dedication to the cause of scientific research. However, there are a few thanks that deserve special attention.

First, Letizia Rodari, who accompanied me, supported me and endured this journey with me at every moment, even in the most difficult times, without ever wavering.

I thank my supervisor, Leonardo Boncinelli, without whom I would not have started on this path in Economics, and who granted me the autonomy I needed to approach different research topics, whether exciting like Game Science or impactful like Behavioral Economics.

I thank the people in the organisations I had the honour of collaborating with, to try and make the world a better place: UNICOOP Firenze, ALIA Spa and DE:HIVE. Thanks to Francesco Ricceri, Giuseppe Meduri, Roberto Marseglia and Thomas Bremer.

Finally, I thank my friends and co-authors, who have made this interdisciplinary journey more fun and constructive. This is not an end, just a new beginning.

Thank you all

Declaration of generative AI and AI-assisted technologies in the writing process

During the preparation of this work the author used ChatGPT-4o for grammar checking. After using this tool/service, the author reviewed and edited the content as needed and take full responsibility for the content of the Ph.D. Thesis.

Introduction

The promotion of pro-social and pro-environmental behaviors has become a critical challenge for modern societies striving to address pressing environmental issues and foster social cohesion. All behaviors should be considered as a part of our cultural heritage and it's a necessity to explore better the mechanisms involved in elicit them. The goal of this dissertation is to explore diverse approaches for encouraging such behaviors, focusing on the role of social norms, economic incentives, and gamification. By analyzing these mechanisms, this work aims to contribute to the broader discourse on how to effectively design strategies and policies that positively influence individual actions for the common good.

The first article examines the impact of social norms on recycling behaviors, investigating how individuals' perception of societal expectations can motivate them to adopt environmentally responsible practices. Social norms are a powerful tool for shaping behavior as they tap into people's desire to conform to what is perceived as socially acceptable, thus promoting collective action in areas like waste reduction and sustainability.

The second article focuses on the implementation of the Pay-As-You-Throw (PAYT) system in waste collection, which introduces economic incentives to encourage waste reduction and recycling. By charging individuals based on the amount of waste they produce, the PAYT system leverages financial mechanisms to nudge households toward more sustainable waste management practices, demonstrating how carefully designed policies can align individual financial interests with environmental goals.

The third article explores the use of games as a tool to foster prosocial behaviors, examining how interactive, playful experiences can be designed to motivate individuals to act in the interest of others. Gamification, through its engaging and reward-based framework, offers a novel approach to behavior change by making the adoption of desirable actions both enjoyable and rewarding.

Together, these three studies provide a comprehensive analysis of different mechanisms, social, economic, and psychological, that can be employed to elicit positive behaviors. By combining insights from behavioral economics, psychology, and public policy, this dissertation seeks to inform the development of more effective strategies for promoting sustainable and prosocial actions in diverse contexts. This work stems from the idea of maximising the impact on behavior to achieve an appropriate behavioral response to policies. Several strategies can be used to elicit different

targets behaviors and there it's possible to find three of the most debated interventions in the flow of literature regarding behavioral and experimental economics.

The mechanisms underlying these changes in behavior are multiple and complex. The main models about behavior change (Davis et al., 2015) are: COM-B (Competence-Opportunity-Motivation-Behavior) TDF (Theoretical Domains Framework) and BCW (Behavior Change Wheel). Although these three have been the main reference, there are other important models to consider for their relevance in the literature. These are the brief introductions to a more complete list of models that are necessary to understand the choices regarding the mechanisms used in the three works included in this thesis.

The COM-B model (West & Michie, 2020) posits that behavior change is a function of three interacting components: capability, opportunity, and motivation. Capability refers to both the physical and psychological abilities required to perform the behavior. Opportunity includes external factors that facilitate or hinder the behavior, such as the social or physical environment. Motivation encompasses both reflective processes, such as conscious decision-making, and automatic processes, such as emotional responses or habits. The COM-B model is widely used in the design of behavior change interventions, offering a straightforward framework to identify and address key behavioral drivers.

The Theoretical Domains Framework (TDF) is an integrative model that combines multiple psychological theories to identify the factors influencing behavior (Atkins et al., 2017). It categorizes these factors into several domains, including knowledge, skills, beliefs about capabilities, social influences, and environmental factors, among others. The TDF provides a comprehensive framework for analyzing behavior from a multidimensional perspective, allowing researchers and practitioners to pinpoint barriers and facilitators to change in a structured way (Francis et al., 2012). It is particularly useful in health and organizational behavior interventions, where complex, multi-level influences need to be addressed.

The Behavior Change Wheel (BCW) is a comprehensive framework for designing behavior change interventions (Michie et al., 2011), built around the COM-B model. At its core, the BCW uses COM-B to diagnose behavioral issues, and it expands to include nine intervention functions, such as education, persuasion, and incentivization, which can be used to modify behavior. Surrounding these are seven policy categories, such as regulation or fiscal measures, which support the implementation of interventions. The BCW provides a structured and systematic approach to developing interventions, ensuring that a broad range of influences on behavior are considered.

The Theory of Planned Behavior (TPB), developed by Ajzen (1991), posits that behavior is determined by the intention to act, which is influenced by three key factors (Ajzen, 2020): attitudes, subjective norms, and perceived behavioral control. Attitudes reflect an individual's evaluation of the consequences of a behavior, subjective norms involve the perceived social pressure to perform or avoid the behavior, and perceived behavioral control refers to the individual's belief about their capacity to execute the behavior. This model is widely used in understanding behaviors related to health, sustainability, and social practices.

The Social Cognitive Theory (SCT), developed by Albert Bandura (1986), emphasizes the importance of observational learning, self-efficacy, and reciprocal determinism in behavior change (Bandura, 2001). Reciprocal determinism refers to the dynamic interaction between personal factors, behavior, and the environment. According to SCT, individuals are more likely to adopt new behaviors if they observe others successfully performing them, believe in their own capability to do so (self-efficacy), and anticipate positive outcomes from the behavior. This model is widely applied in health promotion and behavior change programs.

The Trans-Theoretical Model (TTM), also known as the Stages of Change Model (Hashemzadeh et al., 2019), conceptualizes behavior change as a process that occurs in stages: precontemplation, contemplation, preparation, action, maintenance, and termination. Each stage represents a different level of readiness to change a behavior, and individuals move through these stages at their own pace. The TTM has been especially influential in interventions targeting behaviors such as smoking cessation and weight management, where gradual progression through stages is often necessary.

The Fogg Behavior Model (FBM), proposed by BJ Fogg (2009), suggests that behavior occurs when motivation, ability, and triggers converge. Motivation refers to the individual's desire to perform the behavior, ability is the ease with which the behavior can be carried out, and triggers are the cues that prompt the behavior (Fogg, 2009). The model is particularly useful in the context of persuasive technology and behavior design, offering insights into how to design environments that facilitate behavior change through appropriate triggers and simplicity.

The Self-Determination Theory (SDT), developed by Deci and Ryan (2008), focuses on the intrinsic and extrinsic motivations driving behavior (Deci & Ryan, 2008). According to SDT, individuals are more likely to engage in behaviors when their needs for autonomy, competence, and relatedness are fulfilled. The theory distinguishes between intrinsic motivation, where actions are performed for their inherent satisfaction, and extrinsic motivation, where actions are driven by

external rewards or pressures. SDT has been widely applied in educational, organizational, and clinical settings to promote self-motivated, sustainable behavior change (Slemp et al., 2024).

Many of these models emphasise similar aspects using slightly different, sometimes complementary categories. For each context there are different suitable models for eliciting change and the literature is very varied (Lange et al., 2012, Lo et al., 2012, Davis et al., 2015). The three mechanisms chosen to elicit change in the articles included in this work have different motivations. Social norms are explicitly included in few of the models mentioned above, although the reason lies in the level of abstraction of the models. Those more inclined to provide solutions and those with a greater focus on behavioral determinants. The choice of social norms as a form of intervention lies in the topicality of the literature (Bicchieri, 2017), the ease of implementation and the project dimension. The choice of PAYT tariff lies in the link with a firm (ALIA spa) that it was in the process of making a tariff change in 13 out of 58 municipalities within its area of responsibility. In this case the research project was linked to this change as a natural experiment based on the database of the firm. Incentives as a trigger can be considered included in almost every behavior change model cited before. The last article was about games as a tool of intervention. This is interesting because gamification as a tool is often used but it's not included in the models and based on the results it was a good driver for change. Probably it can be included in the motivational part of the models, considering the specific effect on engagement confirmed by literature (Iannace et al., 2024).

Another important aspect of this work is the link with firms. All projects were in some way connected to policies and strategies of these firms to have a positive impact on society. These firms are ALIA spa and UNICOOP Firenze. Both have a great social responsibilities approach, with the tendencies to invest in prosocial and pro-environmental projects. Linking research projects and impact evaluation to their already existing activities produced the opportunities to advance scientific knowledge in behavioral economics and making their solutions more recognized as a best practice.

Text Structure

The three studies covered in this paper will now be presented, and later in the discussion they will be contextualised in relation to the models of change listed here and will be compared. The references of the studies will be placed at the end of each study, while the references of the introduction and conclusion will be at the end of these parts.

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Chapter 1: First study

Effects of Social Norms, Illusion of Knowledge and Strategic Ignorance on Waste Management Behaviors

Abstract

This study, in collaboration with ALIA Spa, investigates the effects of social norms, the illusion of knowledge, and strategic ignorance on waste management behaviors. Social norms, including trending, top, and static norms, provide a framework for understanding how expectations shape individual actions in waste sorting. The illusion of knowledge, characterized by overconfidence in one's understanding of waste sorting guidelines, often leads to improper disposal practices. Strategic ignorance, defined as the deliberate avoidance of information that could necessitate behavioral changes, further complicates efforts to promote proper waste management. Utilizing a between subject research design, 1,000 participants were surveyed and randomly assigned to four groups (three treatments and one control), to assess their perceptions and behaviors related to waste sorting. Quantitative data were analyzed using correlation and regression techniques. Our findings reveal that norms affect waste sorting behaviors with gender as a moderator, while the illusion of knowledge and strategic ignorance significantly hinder effective waste management. The study underscores the importance of addressing cognitive biases and enhancing community-driven initiatives to improve environmental sustainability. These insights offer valuable implications for policymakers aiming to foster more responsible waste management practices.

Keywords: Behavioral Economics, Waste Sorting, Bias, Environment, Norm-nudging

JEL codes: D91, Q53, C93

Introduction

This paper presents findings from a comprehensive study aimed at elucidating the role of social norms in shaping recycling behaviors within the Tuscan population. Quantitative analysis included measures of recycling frequency, intention, perceived social norms, illusion of knowledge, typical mistakes in waste management, wilful ignorance, and attitude towards recycling. The addition of measurements of waste management competencies and self-efficacy allowed for a deeper insight into the participants' perceptions and experiences related to recycling behavior. In this way, it is possible to look at the effects of social norms on other behavioral tendencies. With an increasing urgency to address environmental issues, understanding the underlying mechanisms that drive individuals' pro-environmental attitudes and behaviors is a goal of fundamental importance (Zorell et al., 2020). In the literature (Saracevic et al., 2021), there are not many comparative studies between more than two norms, as they often require quite high sample sizes. At the same time, the impact of norms on pro-environmental behavior or intentions is observed more without delving into the impact of norms on other psychological constructs (also called latent variables in economics) that are found to have a direct impact on waste sorting behavior (Niu et al., 2023).

The objective of this paper is twofold. The first is to identify the effect of social norms on pro-environmental intentions related to household waste management. The second is to describe some of the cognitive processes associated with incorrect waste disposal behavior, to help the company involved in recognising and managing communication in such a way as to encourage as many people as possible to dispose of waste correctly (Kirkman & Voulvoulis, 2017). This exploratory research aims to identify links between constructs that can help shed light on how to positively influence recycling behavior, in terms of quantity and quality, as so many users make mistakes in waste differentiation (Kala et al., 2020).

Literature review

The proper sorting and disposal of waste are crucial issues for effective waste management and environmental sustainability (Cainelli et al., 2015). However, the adoption of waste-sorting behaviors varies significantly among individuals and communities (Kirkman & Voulvoulis, 2017). Understanding the psychological mechanisms underlying these behaviors can provide insights into how to promote more effective waste management practices (Ragazzi et al., 2024). This literature review focuses on three key psychological constructs: social norms, the illusion of knowledge, strategic ignorance, and their impact on waste-sorting behaviors.

Social Norms

Social norms refer to the shared expectations and rules within a society or group about how individuals should behave (Baughman et al., 2020). These norms significantly influence waste sorting behaviors through both injunctive norms (perceptions of what behaviors are approved or disapproved by others) and descriptive norms (perceptions of what behaviors are commonly performed by others) (Perry et al., 2021). In this survey experiment, three different kinds of norms were used as a treatment and one group figured as a control. The norms used were the trending, the top and the static descriptive ones. The examples of the specific norms are shown in Figure 1.

A **trending norm** refers to a social norm that is currently gaining traction or increasing in popularity within a group or society. This norm indicates behaviors, attitudes, or practices that are becoming more widespread and accepted over time (Mortensen et al., 2019). Individuals are often influenced by trending norms because they signal emerging social patterns that people might want to adopt to stay current or relevant.

A **top-norm** refers to the most prevalent or dominant behavior, attitude, or practice within a group or society at a given time (Rouillé, 2024). These norms represent the highest standard or most widely accepted practice that individuals are expected to follow. Top norms can exert a strong influence on behavior because they embody the peak of social approval and compliance, often associated with significant social rewards or penalties for adherence or deviation (Buvár et al., 2023).

A **static norm** represents long-established and stable behaviors, attitudes, or practices that have been consistently observed within a society or group over time (Dong et al., 2023). These norms do not change frequently and provide a reliable guide for behavior (Campbell et al., 2023). Static norms offer individuals a sense of stability and continuity, as they reflect enduring values and practices that have been maintained and upheld by the community (Sparkman et al., 2020).

Illusion of Knowledge

The illusion of knowledge occurs when individuals believe they know more about a subject than they do (Yang et al., 2020). This cognitive bias can negatively impact waste sorting behaviors by fostering overconfidence in one's ability to sort waste correctly, leading to mistakes and reduced diligence in learning proper sorting methods. Some studies highlighted that many individuals overestimate their understanding of waste sorting guidelines, resulting in higher contamination rates in recycling bins. This overconfidence can prevent individuals from seeking additional information or clarifying doubts, thereby impeding correct waste-sorting practices.

Strategic Ignorance

Strategic ignorance refers to the deliberate avoidance of information that might compel individuals to change their behavior (Nordström et al., 2023). In the context of waste sorting, individuals may choose to remain uninformed about the environmental consequences of improper waste disposal or the specifics of sorting guidelines to avoid the cognitive dissonance associated with their current behaviors (Lind et al., 2019). Strategic ignorance can manifest as reluctance to read waste sorting instructions or avoidance of educational materials provided by municipalities. A lot of individuals often avoid information about waste management practices that would require them to alter their habitual behaviors, indicating a preference for maintaining the status quo (Alexander & O'Hare, 2023). The concept of cognitive dissonance explains why individuals might engage in strategic ignorance. By avoiding information that conflicts with their existing behaviors or beliefs, individuals can reduce the psychological discomfort associated with cognitive dissonance (Hertwig & Engel, 2016). This avoidance can significantly hinder efforts to promote proper waste-sorting practices.

The impact on waste management behaviors

Understanding which social norms are most effective in promoting pro-environmental behaviors can suggest targeted interventions and policy initiatives promoting sustainable waste management practices. By harnessing the power of social norms, policymakers and environmental practitioners can design more effective behavior change interventions tailored to the specific needs and preferences of the Tuscan population. This research contributes to the broader literature on behavioral economics and behavior change by shedding light on the intricate interplay between social norms and recycling behaviors. Moreover, it underscores the importance of context-specific approaches in promoting sustainable behaviors, emphasizing the need to consider local norms and cultural dynamics in intervention design. This study provides actionable insights for policymakers, environmental practitioners, and waste management authorities seeking to promote sustainable practices within the Tuscan community and beyond.

The literature review suggests that social norms exert a significant influence on the recycling behavior of the population, however, it's difficult to find evidence of social norms' impact on other constructs correlated to pro-environmental behaviors (Perry et al., 2021). Specifically, the literature indicates that norms influence plays a crucial role in shaping individuals' attitudes towards recycling and their subsequent behavioral intentions. Moreover, the effectiveness of different interventions varied across groups, highlighting the nuanced nature of social influence mechanisms (Ceschi et al., 2021). The implications are manifold.

Hypotheses

The research questions tested are the following:

1. Do social norms (Static, Trending and Top) impact pro-environmental intentions related to waste management or other constructs?
2. How does the illusion of knowledge influence the liking of different proposed tariffs?
3. Does strategic ignorance of waste management material change after receiving feedback on one's competence in sorting waste?

Methods

Participants

Leveraging a representative sample of 1000 individuals, divided into four distinct groups, this research examines the differential impact of various social norms on recycling behaviors. The sample was stratified into four groups: three experimental groups exposed to different normative influences and one control group. Each experimental group was subjected to a distinct treatment aimed at priming a specific type of social norm, while the control group received no such intervention. Each group was balanced for gender (50%) age (four age groups balanced by the Italian media) and all municipalities in the provinces of Florence, Prato and Pistoia are involved, which are the provinces in which ALIA operates.

Materials

The survey questions were selected from the more recent and well-established literature on social norms, strategic ignorance and the illusion of knowledge. Taking into account the company involved, questions about usual mistakes in waste separation were included for the specific methods used in the target area. The questionnaire included a table with 22 questions asking participants where they should dispose of various types of waste. The company provided the waste list of the most frequent problems found in the collection. The sections of the questionnaire are split as follows:

- Demographics
- Norms Treatments
- Strategic ignorance
- Self-efficacy
- Competence level
- Illusion of knowledge
- Tariff type satisfaction

Variable	Description	Variable	Description
TREATMENT	Social norms administered	D12	12. Crushing plastic packaging (e.g. bottles) before putting them in the recycling bin helps to sort different plastics and send them more easily for recycling. (read)
D0	How much do you think you would increase your commitment to waste separation? Please give a grade from 1 to 10 where 1 means 'a little/not at all' and 10 means 'absolutely/definitely'.	D14	14. Now that you have answered these questions, how would you rate your level of competence in sorting waste? Please give a grade from 1 to 10, where 1 means "not very/not at all competent" and 10 "totally competent".
D1	Let's talk about separate waste collection where you live.1. How informed would you say you are about waste separation in general? Please rate from 1 to 10, where 1 means "not very/not at all informat[O]" and 10 "totally in	D15	15. How interested would you be in seeing some information material on how to sort waste well? Please rate from 1 to 10, where 1 represents "a little/not at all" and 10 represents "very much".
D2	2. How much does receiving clear, relevant and specific information on waste separation have an impact on your waste separation actions? Please give a grade from 1 to 10, where 1 represents 'not much/not at all' and 10 represents 'very much'.	D17	17. Have you ever received the printed information materials (guide and dictionary) produced and distributed by Alia?
D3	3. How interested would you be in seeing some information material on how to sort waste properly? Please give a grade from 1 to 10, where 1 represents "a little/not at all" and 10 represents "very much".	D18	18. Please indicate whether you are still in possession of the printed information materials (guidebook and dictionary) and whether you consult them.
D4	4. How willing[O] are you to make an effort to do better waste separation? Please rate from 1 to 10, where 1 represents 'a little/not at all' and 10 represents 'very much'.	D19	19. To what extent do you consider it necessary/important to have information material on separate collection? (read)
D5	5. In general, how difficult do you think it is to separate waste in your area? Please give a grade from 1 to 10, where 1 represents 'not very/not at all' and 10 represents 'very much'.	D20	20. If you had a greater economic incentive, would you put more effort into sorting? Please rate from 1 to 10, where 1 represents "a little/not at all" and 10 represents "very much".
D7	7. And in your opinion, how many people in your area separate waste correctly?	D21	21. How socially useful do you think it is to do proper waste separation? Please express a grade from 1 to 10, where 1 represents 'not at all' and 10 represents 'very much'.
D8	8. How good do you think you are at sorting your waste? Please express a grade from 1 to 10, where 1 means "not very/not at all good" and 10 "very good".	D22	22. Correctly and carefully sorting waste is considered an altruistic, socially useful and desirable behavior. Knowing that everyone can do better, they will engage more in virtuous waste collection behavior
D9	9. How important is separate waste collection for you? Please give a grade from 1 to 10, where 1 represents 'a little/not at all' and 10 represents 'very much'.	D24	24. Would you like to receive feedback on your TARI specifying how virtuous your waste disposal behavior has been during the year? Please give a grade from 1 to 10, where 1 represents "a little/not at all" and 10 represents "very much".
D10	10. In your opinion, how many people tend to abandon waste? Please rate from 1 to 10, where 1 represents 'none' and 10 represents 'very many'.	D25	25. How much would you like the application of a punctual TARI tariff, where those who differentiate more pay less and those who differentiate less pay more? Please express a grade from 1 to 10, where 1 represents "a little/not at all" and 10 represents "a lot".
D11	11. All packaging, including plastic, metal and poly-bags (such as tetrapaks), must be emptied of their contents before being thrown away.(read)	D26	26. How would you like the application of a TARI tariff by ZONES (district, single municipality), where in areas where you differentiate more you pay less and in areas where you differentiate less you pay more? Please rate from 1 to 10, where 1 represents

Figure 1: List of items in the survey translated in English

Out of the listed questions, there are also three constructs evaluated as follows:

- D2D3Diff = The difference between how much you think the information material has a positive impact and how interested you are in seeing it. It represents strategic ignorance;
- D13SUM = The sum of the right answers out of the 23 in the Figure 2. It represents the competence in sorting waste;
- D8D14Diff = The difference between perceived competence before question D13 and perceived competence afterwards. It represents the illusion of knowledge.

Procedures

In collaboration with ALIA Spa, the company responsible for waste collection and management in central Tuscany, a rigorous survey instrument was developed to capture individuals' recycling behaviors, attitudes, and perceptions of social norms. The Piepoli Institute, a well-known Italian research institute, administered the survey. The method used to administer the questionnaires was mixed (CAWI, CATI and CAMI, 33.3% each). The administration lasted for one month in 2023, from the end of April to the end of May.

Analysis

Statistical methods, such as correlation and regression analyses, examined the relationships between social norms, the illusion of knowledge, strategic ignorance, and waste-sorting behaviors. A Kruskal-Wallis test was used to study the treatment effects by norms conditions. This analysis identifies which factors most strongly influence waste sorting practices.

Results

Descriptives

	Treatment	D0	D1	D2	D3	D4	D5	D7	D8	D9	D10	D11	D12
Mean	1	8.10	7.94	8.06	7.79	8.28	3.28	3.77	8.18	8.91	6.12	1.02	1.05
	2	8.02	7.86	7.97	7.86	8.38	3.20	3.68	8.10	8.91	6.05	1.02	1.10
	3	8.02	7.88	8.03	7.88	8.30	3.20	3.68	8.14	8.92	6.12	1.02	1.08
	4	8.14	7.82	7.99	7.86	8.21	3.02	3.62	8.20	8.84	6.21	1.02	1.04
St. deviation	1	1.47	1.37	1.21	1.67	1.31	2.10	0.945	1.07	1.18	2.46	0.140	0.214
	2	1.73	1.32	1.26	1.40	1.14	2.14	0.982	1.06	1.12	2.49	0.140	0.295
	3	1.48	1.36	1.23	1.39	1.25	2.26	1.06	0.927	1.26	2.49	0.126	0.266
	4	1.52	1.54	1.35	1.57	1.35	2.15	1.02	1.03	1.36	2.48	0.153	0.206

Figure 2: Descriptives with mean and standard deviation splitted by treatments (group 4 is the control group)

	Treatment	D14	D15	D18	D19	D20	D21	D22	D24	D25	D26	D13SUM
Mean	1	7.82	7.84	1.42	1.62	7.96	8.84	8.66	7.46	8.58	7.82	18.8
	2	7.72	7.80	1.43	1.56	8.30	8.86	8.76	7.27	8.58	7.92	18.9
	3	7.77	7.88	1.41	1.58	8.13	8.90	8.72	7.51	8.51	7.76	19.1
	4	7.93	7.83	1.38	1.58	7.94	8.81	8.65	7.16	8.50	7.54	19.3
St. deviation	1	1.27	1.71	0.735	0.624	2.37	1.09	1.17	2.54	1.74	2.47	2.86
	2	1.14	1.53	0.638	0.551	1.98	1.12	1.09	2.55	1.71	2.36	2.72
	3	1.25	1.53	0.704	0.643	2.03	0.951	1.11	2.35	1.64	2.47	2.85
	4	1.16	1.73	0.618	0.604	2.33	1.17	1.21	2.82	1.94	2.79	2.85

Figure 3: This is the second part of the descriptives of Figure 2

Correlation matrix

		D2D3Diff	D4	D5	D7	D9	D10	D13SUM	D8D14Diff	D25	D26
D2D3Diff	Pearson's r	—									
	p-value	—									
D4	Pearson's r	-0.021	—								
	p-value	0.516	—								
D5	Pearson's r	0.022	-0.263 ***	—							
	p-value	0.484	<.001	—							
D7	Pearson's r	0.071 *	0.047	-0.278 ***	—						
	p-value	0.024	0.136	<.001	—						
D9	Pearson's r	0.022	0.457 ***	-0.263 ***	0.085 **	—					
	p-value	0.486	<.001	<.001	0.007	—					
D10	Pearson's r	-0.014	0.184 ***	0.017	-0.240 ***	0.024	—				
	p-value	0.654	<.001	0.583	<.001	0.441	—				
D13SUM	Pearson's r	-0.001	0.108 ***	-0.200 ***	0.123 ***	0.147 ***	-0.087 **	—			
	p-value	0.970	<.001	<.001	<.001	<.001	0.006	—			
D8D14Diff	Pearson's r	0.025	0.067 *	0.034	0.014	0.136 ***	-0.102 **	-0.395 ***	—		
	p-value	0.434	0.035	0.280	0.650	<.001	0.001	<.001	—		
D25	Pearson's r	-0.012	0.214 ***	-0.188 ***	0.039	0.280 ***	0.136 ***	0.084 **	-0.058	—	
	p-value	0.697	<.001	<.001	0.217	<.001	<.001	0.008	0.066	—	
D26	Pearson's r	-0.035	0.320 ***	-0.190 ***	-0.025	0.225 ***	0.228 ***	-0.082 **	-0.001	0.445 ***	—
	p-value	0.272	<.001	<.001	0.425	<.001	<.001	0.010	0.977	<.001	—

Note. * p < .05, ** p < .01, *** p < .001

Figure 4: This figure is a selection of items in a correlation matrix to better understand which constructs are related to others. Some of them are very strong correlated and the competence score (D13SUM) has a significant effect on almost every other item.

Competence Score

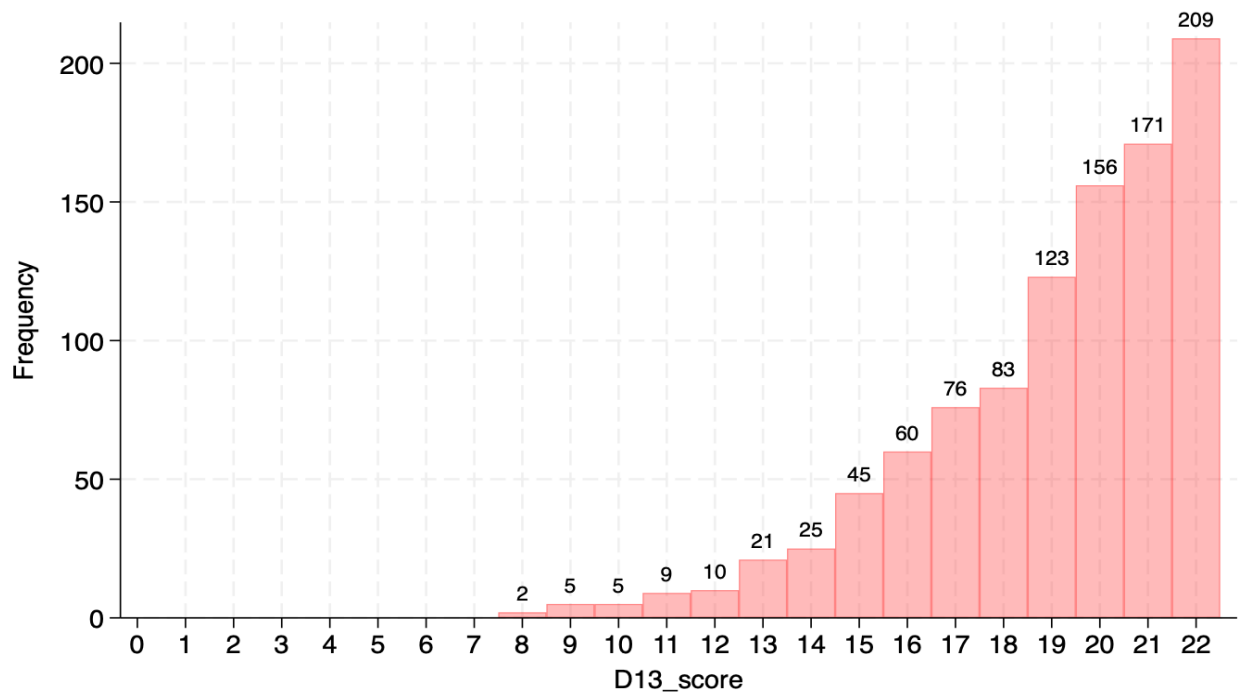


Figure 5: Here is represented the quantity of the sample that completed correctly the item D13, composed by 22 sub-items to determine the effective competencies on waste management

Final models

Variables	Model 1	Model 2	Model 3	Model 4
Treatments				
Static	0.217 (0.139)	0.439** (0.202)	0.406** (0.166)	0.433*** (0.166)
Trending	0.134 (0.139)	0.296 (0.202)	0.300* (0.165)	0.320* (0.165)
Top	0.129 (0.139)	0.378* (0.202)	0.372** (0.165)	0.382** (0.165)
Gender				
Female	0.055 (0.099)	0.355* (0.197)	0.282* (0.162)	0.288* (0.162)
Age Cat.				
18-34	-0.086 (0.157)	-0.085 (0.157)	-0.071 (0.129)	-0.082 (0.129)
55-64	0.003 (0.139)	0.001 (0.139)	-0.096 (0.114)	-0.091 (0.114)
Over 64	-0.078 (0.121)	-0.076 (0.121)	-0.030 (0.099)	-0.029 (0.099)
Treatments X Gender				
Static X Female	–	-0.422 (0.279)	-0.362 (0.228)	-0.391* (0.229)
Trending X Female	–	-0.308 (0.279)	-0.260 (0.229)	-0.280 (0.229)
Top X Female	–	-0.474* (0.279)	-0.470** (0.229)	-0.480** (0.229)
Additional Variables				
Informed	–	–	0.068* (0.038)	0.064* (0.038)
Info Effectiveness	–	–	0.369*** (0.046)	0.375*** (0.046)
Info interset	–	–	0.215*** (0.032)	0.216*** (0.032)
Difficult	–	–	-0.061*** (0.020)	-0.055*** (0.020)
Self Assessment	–	–	0.166*** (0.048)	0.156*** (0.048)
Knowledge Score	–	–	–	0.028* (0.015)
Constant	7.954*** (0.127)	7.794*** (0.156)	1.493*** (0.408)	0.986** (0.489)
Adjusted R^2	-0.0036	-0.0031	0.3288	0.3305
Observations	1,000	1,000	1,000	1,000

Figure 6: In this Figure is possible to see the four stage of the model that was built to explain the main outcome of the study. The mediation of the gender and the effect of competence score are the most important variable involved in explaining the variance. It will be better explained in the discussion

Discussion/conclusion

With an increasing urgency to address environmental concerns, understanding the underlying mechanisms that drive individuals' pro-environmental attitudes and behaviors is of fundamental importance. This paper presents findings from a comprehensive study aimed at elucidating the role

of social norms in shaping recycling behaviors and other psychological mechanisms involved in pro-environmental attitudes. Understanding the psychological mechanisms underlying these behaviors can provide insights into how to promote more effective waste management practices and a more adapted tariff to elicit better behaviors. The Kruskal-Wallis results show none of the effects is significant. By adding covariates in a set of linear regressions as in Figure 6, an effect can be noticed only when running the analysis adding the gender variable as a mediator, highlighting that there is an effect prevalent on men. This possible heterogeneity of the treatment effects could suggest some future interventions that target only some specific subgroups. Then, this possibility will be subject to future investigation in subsequent studies. In literature, a visible trend can be observed in the response distributions. Participants show a general tendency to give answers that lie between 7 and 8 on the 10-point Likert scale. This can be also an improvement for future studies by shifting towards a 7 points Likert scale.

In the regressions, one can observe the effects of the main constructs on the liking of the two tariffs, but the one value that appears to contribute the most is how much one is willing to increase one's commitment. The more the willingness to increase it, the more one likes the spot tariff. For what concerns the illusion of knowledge, the higher it is, the less they like the point tariff. Other interesting results emerge from the correlation matrix (Figure 4). First, it is possible to notice how perceived difficulty correlates negatively with all questions that have a positive impact on the likelihood of good waste separation. It can also be observed that as perceived difficulty increases, performance in the questions on sorting errors decreases. Perceived difficulty also influences the implicit social norm people have about how many people they think tend to sort correctly (Questions D7 and D5). Specifically, the more they think doing it is difficult, the lower their estimate of the number of people they think tend to do it in their area. Moreover, a high level of knowledge illusion is correlated with a high importance attached to sorting and a low performance in Figure 5 on competence. Strategic ignorance is only weakly correlated with the positive expectation of how many people sort waste in their area (Question D7), something that is worth being subject to further investigations. The correlations are also significant when applying the Bonferroni reduction, except in the case of strategic ignorance, meaning that (at least in general) they are robust.

In Figure 6 is reported the OLS regression analysis in order to evaluate the impact of different social norm treatments (static norm, trending norm, and top norm) on participants' intentions to increase their commitment to recycling, measured on a scale from 1 to 10. The control group serves

as the baseline for comparison. The Figure is articulated in four different model specifications as described below.

In Model 1, was examined the basic effects of the three treatments on recycling intentions, controlling for gender and age categories. The results indicate that all treatments have a positive coefficient but are not statistically significant. Also results for gender and age categories do not show significant effects. Moreover, the adjusted R-squared for the baseline model is -0.0036, indicating that at this level of specification the model has very low explanatory power.

Model 2 builds upon Model 1 by including interaction terms between each treatment and gender to explore if the effects of the treatments differ by gender. The single feature effects (Treatments and Gender) are important to interpret alongside the interactions. The coefficient for the static norm treatment increases to 0.439 and becomes significant at the 5% level. The trending norm treatment coefficient is 0.296, which remains non-significant, while the top norm treatment coefficient increases to 0.378, significant at the 10% level. The coefficient for female participants is now 0.355, significant at the 10% level, suggesting a positive main effect of being female on recycling intentions when at the baseline level, therefore when no treatment is in place. For the interaction terms, for static and trending norms and gender are not statistically significant. However, the interaction term for the top norm is negative (-0.474) and is significant at the 10% level, indicating that the effect of the top norm treatment is less positive for female participants compared to their male counterparts. The adjusted R-squared for Model 2 is -0.0031, suggesting that the inclusion of interaction terms does not substantially improve the model's explanatory power.

In Model 3, additional covariates have been included in the regression analysis, such as: Informed, which represents how much the participant deems himself informed about recycling activities; Info Effectiveness, indicating how important the individual thinks being informed about good practices is; Info Interest, i.e., the participant's level of interest in acquiring additional knowledge about recycling activities; Difficulty, refers to the perceived level of difficulty in recycling; and Self-Assessment, which reflects the respondent's perception of their own proficiency in recycling. The inclusion of these variables significantly enhances the model's explanatory power, with the adjusted R-squared increasing to 0.3288. In this model, the static norm treatment shows a positive and statistically significant coefficient of 0.406, indicating that this treatment positively impacts recycling intentions. The trending norm treatment has a positive coefficient of 0.300, which is significant at the 10% level, while the top norm treatment has a coefficient of 0.372, significant at the 5% level. The coefficient for female participants is 0.282, which is significant at the 10% level, indicating a positive effect of gender on recycling intentions. The interaction term for the top norm

and female remains significant at the 5% level, with a coefficient of -0.470, reinforcing the finding that the top norm treatment is less effective for female participants. As for the additional covariates, they all show significant results, highlighting the importance of perceived information effectiveness and difficulty, interest in information, and self-assessment in shaping recycling intentions.

Finally, Model 4 incorporates into the analysis an additional covariate, Knowledge Score, which captures the actual knowledge of the individual concerning a set of recycling behavior. This model further improves the explanatory power, with an adjusted R-squared of 0.3305. In this model, with respect to the previous one (Model 3) was observed that the static norm treatment becomes significant at the 1% level with a coefficient of 0.433. Moreover, the interaction between the static norm and being a female becomes significant at the 10% level. Among the additional covariates, the knowledge score shows a positive and marginally significant effect at the 10% level. In summary, final results indicate that the three norm treatments (at different significance levels) positively influence recycling intentions, with the top and static norm being less effective for female participants.

Briefly, the hypotheses tested are the following:

1. Do social norms (Static, Trending and Top) impact pro-environmental intentions related to waste management or other constructs?
2. Does the illusion of knowledge influence the liking of different proposed tariffs?
3. Does strategic ignorance of waste management material change after receiving feedback on one's competence in sorting waste?

The answer to the first research question is partially positive. Social norms significantly impact pro-environmental intentions with a stronger effect based on gender. This result is unexpected compared to the literature, as the effects are usually found to be significant, albeit minimal, in both genders. There are several possible explanations for the effect size. The first is that the population in the surveyed provinces is already overexposed to norms and many other communication channels and strategies on plenty of pro-environmental aspects. Indeed, 87% of the waste managed is already differentiated (from ALIA data). If the starting percentage had been lower in both cases (the percentage of differentiated waste and the percentage of people performing the desired behavior), it is reasonable to assume that a stronger effect would have occurred. Standards serve to improve the behavior of those who tend not to have had a trigger for the correct one(s). But, in a virtuous region, this occurs in a smaller percentage of cases. This results in a downside to the starting hypothesis but allows for aggregation of the four groups for the subsequent hypotheses-related analyses without worrying about the possible interference effects of the treatments.

The response to the second question is positive. The higher the illusion of knowledge, the less participants like the PAYT tariff. For every point of difference, they support -0.19 the tariff. This is interesting because the knowledge illusion represents the discrepancy between how much people think they know and how much they do (and do not) know after receiving feedback on their knowledge. Reasonably, this means that the greater this discrepancy, the less people would accept a more calibrated rate on their behavior. So, in the first place it is possible to state that, in case the policymaker wants to (or has to) promote the PAYT in some specific zones, the illusion of knowledge could be tested as a treatment to raise people's support for it. Otherwise, it can still be useful to measure it considering the will to target with diversified means the different agents to maximize the impact of a certain policy (by applying it in a tailored way). On the other hand, to make the point tariff more effective, it would be possible to correct the illusion of knowledge through appropriate strategies. It would be possible to make people accept a better rate when identifying negative behavior towards the environment. To counter the illusion of knowledge, educational interventions that highlight common misconceptions and provide clear, actionable guidelines have proven effective. For instance, providing visual aids or detailed instructions on waste sorting can help bridge the gap between perceived and actual knowledge.

Finally, the answer to the third question is positive. It is possible to see some positive correlations between strategic ignorance and other questions, such as interest in information material, which increases after receiving feedback in the table in question D13. In general, the more informed a person thinks he or she is, the more he or she thinks the information can have a significant impact on people's behavior, but his or her interest in viewing further material also declines. This tendency declines after receiving feedback.

In addition to the research questions, other things emerged that were useful for the company to know. The older the individuals, the more likely they are to have received and retained ALIA's information material. This implies that it would be important to give more focus to distributing such material to younger segments of the population, perhaps by including a nudge at the time of TARI registration (the annual tax about waste in Tuscany). Also, the evaluation of other communication channels and strategies could be useful, to test if there is a lower interest from the younger generations or if the lack of information materials retention is given by a poor choice of communication means only. Also, the economic incentive seems to be more attractive to older segments of the population, while, regardless of age, recognising good recycling behavior as an altruistic act correlates positively with all questions that detect positive waste management intentions. This may suggest that pushing altruistic behavior and a sense of community could have a

general positive impact on those who do not yet systematically engage in pro-environmental behavior, something that is already suggested by the literature (Birkenbach & Egloff, 2024) and should be tested in future studies with the specific population and other ones as a possibly useful treatment.

Limitations of the study

The study has several limitations. The first is predominantly the telephone administration methodology. The low effect of norms may be due to the relatively lower impact of this mode of administration in capturing and internalising the norm, as listening is a behavior that is much more passive concerning reading. This is in contrast with the Elaboration Likelihood Model (ELM) theory, a well-established persuasion theory that conveys the idea the more the active role of the subject is persuaded in the elaboration of information, the more the impact of the persuasion (Petty & Cacioppo, 1986).

The second is the limitation to the three provinces, which implies poor generalisability even though the sample shares reflect the national population by gender and age. Further studies should try to continue testing these kinds of treatments on representative samples rather than convenience ones, to clarify more robustly their possible impacts and scalability. Only in this way would it be possible to spread solid evidence about these topics, to see when they can be effective as behaviors, attitudes and intentions change tools.

Finally, being an exploratory study, apart from the impact of the norms, the other analyses are only correlations, thus lacking a cause-effect link that could have been seen with the norms instead. So, it does not give causal explanations about the various issues, but it points out some interesting issues to be further investigated in the future.

Suggestions for future research

In this exploratory research, it was possible to explore several correlations and insightful ideas that suggest several future developments. The first thing would be to replicate the norms study in a less sensitised population, to see if the effect would be greater and significant in that case, perhaps with a written-only administration of the survey experiment. It's important to deepen the effect of gender on norms, possibly finding a way to identify the mechanism prevalent in determining a greater effect on men (which could be the tendency to compete, top-norm and static norm being more impactful).

The second thing would be to further explore the illusion of knowledge and strategic ignorance impacts on the other variables observed. This should be done by using them as treatments and thus being able to identify the cause-effect link rather than the correlation.

The third thing is the study of subjective norms related to objective norms. People's implicit expectations of others' behavior may be impacted by explicitly stated norms or vice versa. This kind of connection between subjective and objective, implicit and explicit social norms is an interesting knot to unravel to understand when social norms can have an impact. Finally, based on the identified correlations, it would be interesting to test the impact of different nudges in reducing the number of mistakes people make in sorting waste.

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Chapter 2: Second study

Impact of Pay-As-You-Throw Waste Collection Strategy on Recycling Behavior: A Field Experiment in Tuscan Municipalities

Abstract

This article explores the effects of a Pay-As-You-Throw (PAYT) waste collection system on recycling behaviors in selected municipalities in Tuscany. The study investigates the outcomes of the PAYT framework on recycling behaviors within households utilizing a door-to-door waste collection approach. Using a rich dataset from diverse municipalities, the research uncovers varying responses to the PAYT system across demographic groups and time, providing valuable insights into the real-world impacts of PAYT policies. This research contributes to a deeper understanding of the dynamics influencing recycling behaviors under the PAYT model and lays the groundwork for targeted policy interventions and future investigations in sustainable waste management practices.

Keywords: Behavioral Economics, Waste Sorting, Incentives, Environment, Behavioral design

JEL codes: D91, Q53, C93

Introduction

In the pursuit of sustainable waste management practices, the implementation of innovative and effective waste collection systems is paramount. Pay-As-You-Throw (PAYT) has emerged as a promising approach, linking waste disposal costs to individual behavior and incentivizing responsible waste management. The Pay-As-You-Throw (PAYT) system, also known as unit pricing or variable-rate pricing, is an increasingly popular waste management approach that charges users based on the amount of waste they generate (Gradus et al., 2019). This method aims to create an economic incentive for individuals and businesses to reduce waste, increase recycling, and promote environmentally sustainable behaviors (Elia et al., 2015). In contrast to flat-rate waste collection systems, which charge users the same fee regardless of waste quantity, PAYT encourages more responsible consumption and waste disposal practices (Brown & Johnstone, 2014).

This study delves into the impact of PAYT on recycling behaviors within the unique context of municipalities in Tuscany, employing a door-to-door waste collection method. The significance of understanding the outcomes of PAYT systems lies in their potential to influence positive environmental practices, reduce landfill contributions, and optimize resource recovery (Bringsken et al., 2019). While PAYT schemes have been widely adopted, the nuances of their impact on diverse demographic groups and their corresponding recycling behaviors remain underexplored (Bonelli et al., 2016). Our research addresses this gap by focusing on the outcomes as a result of PAYT implementation rather than solely analyzing the system (Starr & Nicolson, 2015). Tuscany, with its rich cultural heritage and diverse socio-economic landscape, provides an ideal backdrop for studying the varied responses to PAYT (Emmanouil et al., 2022). Through meticulous data collection across a sample of municipalities, the aim was to unravel the intricacies of recycling behavior within the context of PAYT (Bilitewski, 2008). This study not only contributes to the academic discourse on waste management but also holds practical implications for policymakers and municipal authorities (Šauer et al., 2008). Insights gleaned from this research can inform targeted interventions, optimizing the effectiveness of PAYT systems and fostering sustainable waste management practices (Batllellé & Hanf, 2008). Navigating the intricate interplay between PAYT and recycling behaviors, these findings aim to enhance the knowledge base, offering a valuable resource for both academic and practical advancements in the field of waste management (Lakhan, 2015).

Literature review

The effective management of municipal solid waste is a critical aspect of contemporary urban planning (Seacat & Boileau, 2018), necessitating innovative approaches to minimize environmental impact and encourage sustainable practices (Reichenbach, 2008). A pivotal component in this discourse is the examination of waste collection methods and their influence on household recycling behaviors. A comprehensive understanding of these dynamics (Beccarello & Di Foggia, 2022) is the foundation for the present study on the outcomes resulting from Pay-As-You-Throw (PAYT) waste collection in Tuscany.

The selection of waste collection methods significantly shapes recycling behaviors (Barraca et al., 2019). Traditional approaches like curbside collection and drop-off points have been prevalent (Chen et al., 2017), but the introduction of PAYT systems represents a transformative shift (Buccioli et al., 2015). PAYT aligns waste disposal costs with individual responsibility, and previous research has explored its impact on incentivizing waste reduction and proper disposal (Puig-Ventosa, 2008). Comparative analyses of different collection modalities have considered factors such as convenience, accessibility, and financial implications (Alzamora & Barros, 2020). Understanding user responses to diverse waste collection systems is crucial for optimizing waste management strategies (Sakai et al., 2008). Studies have delved into behavioral nuances associated with various collection methods, considering elements like convenience, accessibility, and financial consequences. PAYT systems have been examined for their capacity to promote conscientious waste disposal practices and mitigate environmental degradation (Le Bozec, 2008). Beyond the choice of collection method, the literature explores strategies for balancing tariffs to drive sustainable behaviors (Reis et al., 2015, Puig-Ventosa, 2008). Effective tariff structures play a pivotal role in influencing consumer choices, encouraging responsible waste disposal, and discouraging excessive waste generation (Pérez et al., 2021). Research in this domain emphasizes the importance of aligning pricing models with environmental objectives (Huang et al., 2011), considering factors such as fairness, economic feasibility, and social impact (Karagiannidis et al., 2005). By reviewing existing literature on waste collection modalities and their impact on user behavior, this study aims to contribute to the evolving discourse surrounding sustainable waste management practices. The incorporation of insights into tariff structures enhances the understanding of how pricing mechanisms can be leveraged to promote environmentally responsible behaviors (Messina et al., 2023), providing valuable implications for waste management policies, particularly in the context of PAYT implementation in Tuscany. The literature supports PAYT as a viable tool for reducing waste, promoting recycling, and fostering pro-environmental

behaviors. While challenges exist, particularly related to equitable implementation and community buy-in, PAYT's flexible, incentive-based approach offers municipalities a promising strategy for sustainable waste management. Effective implementation hinges on comprehensive planning, community engagement, and policy integration to ensure that PAYT maximally benefits both the environment and residents (Morlok et al., 2017).

Methods

The uniformity criterion in waste collection methods guided the selection of municipalities for this study. In order to ensure a cohesive and comparable dataset, municipalities within the Tuscany region were chosen based on the consistency of their waste collection modalities. The focus on uniformity aims to minimize confounding variables, allowing for a more accurate assessment of the impact of the Pay-As-You-Throw (PAYT) system on recycling behaviors. The final selection of municipalities is 13 out of 58 that are under the jurisdiction of ALIA Spa. In 13 municipalities, the PAYT system was introduced as of January 2023. The study encompasses data for the years 2021, 2022 and 2023, incorporating information from approximately 209,000 households across the selected municipalities. This dataset provides a robust foundation for analyzing results from the implementation of PAYT in a diverse and representative sample. To safeguard the anonymity of the data provided by this waste management company, direct demographic information is not included in our dataset. Instead, demographic details at the municipal level are limited to those publicly available through the Italian National Institute of Statistics (ISTAT). This approach ensures compliance with privacy and ethical considerations while still enabling a comprehensive examination of recycling behaviors under the PAYT framework. By selecting 13 municipalities with uniform waste collection practices and employing stringent privacy measures, the aim was to offer a reliable and insightful exploration of the dual-curve outcomes associated with PAYT implementation in Tuscany. This participant selection strategy enhances the internal validity of our study, allowing for more confident inferences regarding the impact of PAYT on recycling behaviors within the specified context.

Materials

The dataset encompasses records of waste disposal behaviors and associated tariff structures across multiple municipalities from 2021 to 2023. Each entry contains unique identifiers such as contract codes ('utenza'), account codes ('account'), and property codes ('impianto'). Waste volumes are recorded for various categories including undifferentiated waste ('NRW'), organic waste ('organico'), paper waste ('carta'), and multi-material waste ('multi'). The volume of separated waste, calculated as the sum of organic, paper, and multi-material waste, allowed us to compute the

percentage of separated waste as the total volume of recycled waste on total waste delivered ('RW), provides insights into citizens' engagement with separate waste collection. Municipalities with door-to-door waste collection systems are represented in the dataset. Notably, the transition to a new tariff system in 2023 prompted changes in data recording schemes, requiring data engineering operations for standardization. This dataset facilitates the analysis of individual users' waste disposal behaviors and the impact of tariff adjustments on separate waste collection percentages over time.

Analysis

RD is computed as:

$$RD\%_i = \frac{RD_i}{RD_i + RUI_i}$$

- $RD\%_i$ is the percentage of separate collection made by the user i
- RD_i is the sum in liters of organic, multimaterial and paper waste delivered by the user i
- RUI_i is the sum in liters of unsorted waste delivered by the user i

Model for tariff

The PAYT tariff is calculated as follows:

$$Tariff_a = TF + (TVmin - RID) + T_o$$

Where: TF is the fixed part of the tariff. $TVmin$ is the variable part of the tariff corresponding to minimum emptyings, T_o is the variable part of the tariff corresponding to emptyings exceeding the minimum, RID is the reduction of the variable tariff quota (corresponding to minimum emptyings) associated with measurements consistent with virtuous environmental behavior.

Domestic Users

Fixed part

$$TF_d(n, S) = Qu_f \cdot S \cdot Ka(n)$$

$TF_d(n, S)$ is the fixed part of the tariff for a domestic user with n household members and area S of the dwelling

$Qu_f = \frac{C_{tuf}}{\sum_n^2 S_{tot}(n) \cdot Ka(n)}$ is the unit share for the fixed part of the tariff for domestic users expressed in €/m², corresponding to the ratio of fixed costs chargeable to domestic users to the total areas referable to domestic users

$Ka(n)$ Is the adjustment coefficient for area given the number of household members n

Variable part

$$TV_d(n) = TVmin + To = Quv_d \cdot l_{min}(n) + Quv_d \cdot l_{extra}$$

- $TV_d(n)$ is the variable part of the tariff for a domestic user with n household members
- $Quv_d = \frac{ctv_d}{\sum_n 2l_{min}(n)}$ is the unit share for the variable part of the tariff for domestic users expressed in €/m², corresponding to the ratio of total variable costs to total minimum liters
- $l_{min}(n)$ is the number of annual liters of undifferentiated waste allocated to the household with n components according to the following scheme:

Components n	l_{min}
1	80
2	160
3	240
4	320
5	400
> 5	480

Figure 1

- l_{extra} are the measured liters of undifferentiated liters that exceed the minimum reference liters of the domestic user category

Reductions

The reductions are a portion (agreed with ARERA) of revenues from the sale of materials and energy derived from waste. The portion of reductions that accrues to domestic users is allocated proportionally with respect to the associated $l_{min}(n)$. Only users with a separate collection rate greater than or equal to 0.7 are eligible for reductions and are exempt from paying extra liters. Users with rates less than or equal to 0.4 do not have access to the reductions and must pay for the additional liters. All other utilities, with rates between 0.7 and 0.4, do not pay for excess liters and do not have access to reductions.

Non-domestic Users

For non-domestic users, the tariff works the same as for domestic users. The differences are:

- Instead of the category by number of household members, have the category by type of activity (e.g., schools, restaurants, hospitals, etc.). As a consequence, there are different coefficients for adjusting the area.
- The minimum annual liters of undifferentiated waste for all non-households is determined by the number of liters of the RUI container provided to the user multiplied by 24 (2 emptyings per month).

Difference-in-Differences

This study aims to assess the impact of the PAYT tariff policy introduction, a tariff designed to incentivize higher recycling rates, which was implemented in some Tuscan municipalities. To evaluate its effect on recycling behavior, a Difference-in-Differences (DiD) approach is employed.

The DiD estimates are based on a dataset of 58 municipalities, 13 of which adopted the PAYT system starting from the beginning of 2023, while the remaining 45 municipalities did not. The methodology aims to estimate the Average Treatment Effect on the Treated (ATET) by comparing the outcomes of treated and non-treated municipalities before and after the policy's implementation. This setup leverages both cross-sectional variation (treated versus non-treated municipalities) and temporal variation (before versus after policy implementation). The underlying assumption in this DiD framework is that, in the absence of the policy, the percentage of recycled waste and the tons of non-recycled waste would have followed similar trends in both treated and non-treated municipalities. This is known as the parallel trends assumption and is crucial for identifying the causal impact of the policy.

The analysis employs a Difference-in-Differences (DiD) approach to estimate the impact of the PAYT policy on two dependent variables: the percentage of recycled waste and the tons of non-recycled waste. The following model is used:

$$Y_{it} = \alpha + \beta_1 \text{post}_t + \beta_2 \text{treated}_i + \delta(\text{post}_t \times \text{treated}_i) + \gamma_i + \lambda_t + \epsilon_{it}$$

Where:

- Y_{it} is the outcome variable for municipality i at time t . In this analysis, the outcome variable is either the log of the percentage of recycled waste or the log of the tons of non-recycled waste
- α is the intercept.
- post_t is an indicator variable that takes the value of 1 for observations in the post-policy period (after the implementation of the PAYT) and 0 for the pre-policy period.

- treated_i is an indicator variable that takes the value of 1 if the municipality is in the treated group (i.e., those that implemented the PAYT) and 0 otherwise.
- The interaction term $\text{post}_t \times \text{treated}_i$ captures the difference-in-differences effect, which estimates the effect of the policy on the treated municipalities after the policy was implemented. The coefficient δ represents the Average Treatment Effect on the Treated.
- γ_i represents municipality-specific fixed effects that control for time-invariant characteristics of each municipality.
- λ_t represents time-specific fixed effects that control factors that affect all municipalities equally over time.
- ϵ_{it} is the error term that captures the unexplained variation.

The key coefficient of interest is δ , which estimates the causal impact of the PAYT policy. This coefficient shows the difference in the outcome variable between treated and non-treated municipalities after the policy implementation, controlling municipality- and time-specific effects.

Results

As for the analysis of Recycled Waste (RW), the coefficient for the treatment effect on the percentage of recycled waste RW is 0.002, with a p-value of 0.886. This result indicates that the policy did not have a statistically significant effect on recycling rates. The ATET is close to zero, implying that there was virtually no difference between the treated and non-treated municipalities in terms of the percentage of recycled waste after the policy was implemented.

The 95% confidence interval for the ATET ranges from -0.031 to 0.036, which further supports the conclusion that the PAYT had no meaningful impact on recycling rates.

Dep. Var.t: RW (ln)	Coefficient	Robust Std. Err.	t	P> t	[95% Conf. Interval]
ATET	0.002	0.017	0.14	0.886	-0.031 to 0.036

Figure 2

A key assumption of the Difference-in-Differences (DiD) approach is that the trends in the outcome variables would have been the same for both the treated and control groups in the absence of intervention. To test whether this assumption holds, was performed parallel trends tests. The F-statistic for this test was 1.08, with a p-value of 0.303, suggesting that the pre-treatment trends between the treated and control groups are not statistically different.

The trends plot, shown in Figure 2, provide a visual confirmation of the results. In the case of recycled waste, the graph confirms that both treated and non-treated municipalities followed parallel trends before the policy's implementation in 2023, which supports the key assumption of the DiD approach. However, after 2023, the treated municipalities do not exhibit a substantial increase in recycling rates compared to the non-treated municipalities. This observation is consistent with the regression results, which indicate no significant effect of the policy on the percentage of recycled waste.

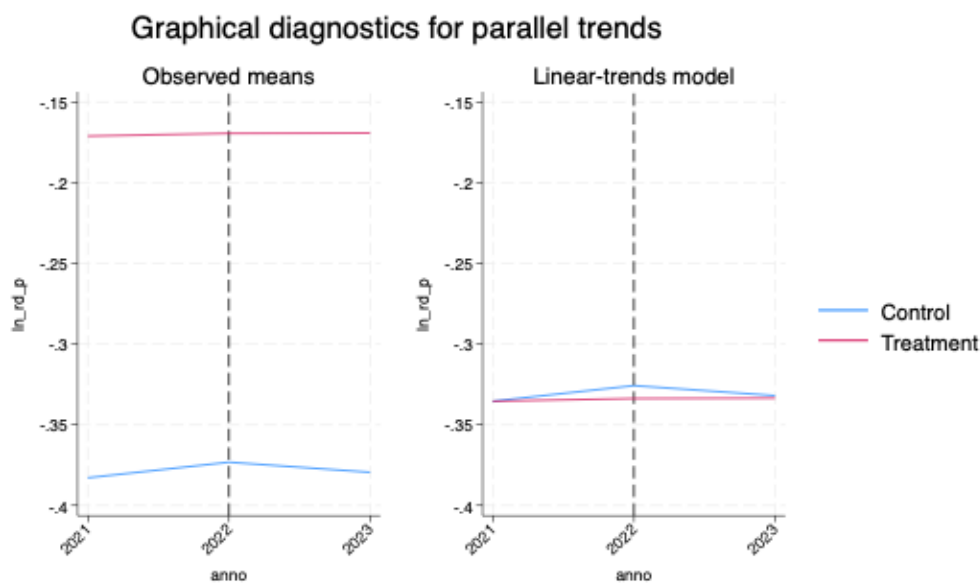


Figure 3

This lack of significance might indicate that the policy, while designed to incentivize recycling, was not sufficiently powerful or well-targeted to generate a measurable increase in recycling behavior. Alternatively, there may have been implementation challenges or public resistance to the tariff that limited its effectiveness. Another possibility is that it may simply be too early to observe any meaningful effects of the PAYT, as behavioral changes related to recycling could take time to materialize. Policies such as these often require a longer adjustment period before measurable impacts can be detected, and it is possible that more time is needed for the policy's intended effects to fully take hold.

For the tons of Non-Recycled Waste (NRW), the ATET coefficient is -0.067, with a p-value of 0.012. This result is both statistically significant and negative, indicating that the PAYT led to a reduction in non-recycled waste in treated municipalities. The 95% confidence interval ranges from -0.1205 to -0.0153, reinforcing the robustness of this finding.

The fact that the coefficient is significant at the 5% level ($p = 0.012$) provides strong evidence that the policy successfully altered waste disposal behavior in the treated municipalities, even though the effect is relatively small.

Dep. Var.t: NRW (ln)	Coefficient	Robust Std. Err.	t	P> t	[95% Conf. Interval]
ATET	-0.067	0.026	-2.59	0.012	-0.1204 to -0.015

Figure 4

For the NRW, the results of the parallel trends test reported an F-statistic of 0.00, with a p-value of 0.95. Since this p-value is much greater than conventional significance levels, failing to reject the null hypothesis, meaning that the pre-treatment trends for the treated and control groups are not statistically different. This indicates that the groups were evolving similarly prior to the implementation of the PAYT, providing strong evidence that the parallel trends assumption holds for the analysis of non-recycled waste.

The graph (Fig. 3 and 4) shows, indeed, that both groups exhibited similar trends before the policy's implementation, and following the introduction of the PAYT in 2023, treated municipalities experienced a more pronounced reduction in non-recycled waste compared to non-treated municipalities. This trend supports the statistically significant result from the regression analysis, which shows that the policy led to a reduction in non-recycled waste. However, the control group also exhibited changes in the post-treatment period, suggesting that both groups were influenced by factors outside of the PAYT policy. This complicates the interpretation of the treatment effect, as the changes in the control group may confound the estimated policy impact. It raises the possibility that the observed differences between treated and control municipalities could be partially driven by other unobserved factors. Therefore, these findings should be interpreted with caution, and further analysis is necessary to disentangle the effects of the policy from other concurrent influences.

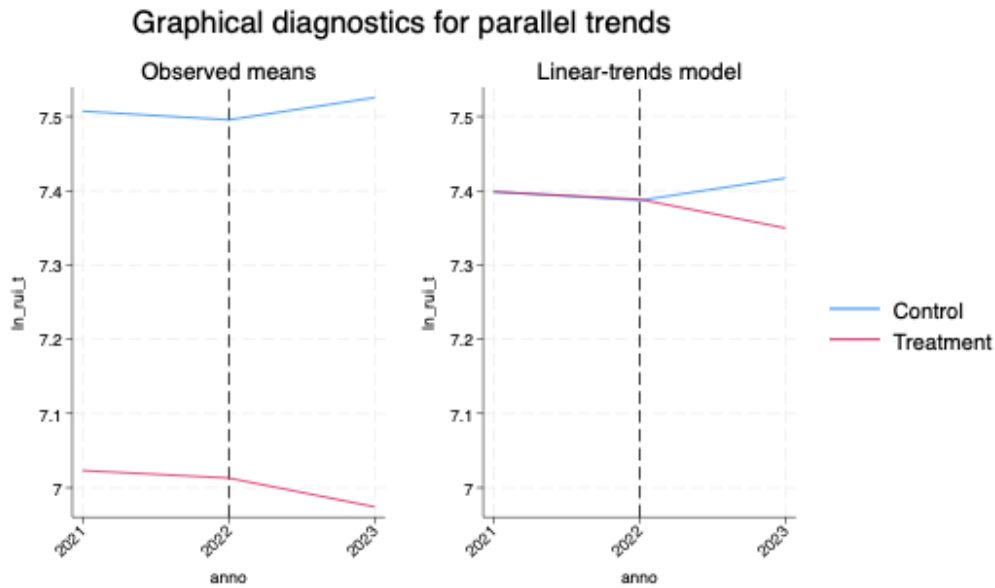


Figure 5

At first glance, results obtained for the RW and the NRW may seem contradictory, as one might intuitively expect a reduction in non-recycled waste to coincide with an increase in the percentage of recycled waste. However, it is important to note that RW measures the percentage of recycled waste, while NRW is measured in tons of non-recycled waste. Although these outcomes are related, they are not identical. It is possible for non-recycled waste to decrease without a proportional increase in the recycling rate, particularly if the total amount of waste generated also decreases. This could happen, for instance, if people reduce overall consumption or waste production as a response to the tariff (e.g., they avoid generating waste altogether). As a result, less waste is going to both recycling and disposal, leading to a reduction in NRW without a corresponding increase in the percentage of RW.

It's also plausible that recycling behavior changes more slowly than the reduction of total waste. For example, people may first respond to the tariff by simply producing less waste (thus decreasing NRW), but they may take more time to adjust their behavior in terms of separating materials for recycling. Thus, the full effect on recycling rates may not be immediate, explaining why you see a significant effect on NRW but not yet on RW.

Discussion

This study investigates the impact of the Pay-As-You-Throw (PAYT) waste collection system on recycling behavior in Tuscan municipalities. By aligning waste disposal costs with individual household behavior, PAYT incentivizes more responsible waste management practices. This research adds to the academic discourse on sustainable waste management and offers practical

insights for policymakers aiming to optimize waste reduction strategies and recycling engagement. The analysis employed a Difference-in-Differences (DiD) approach, comparing municipalities with and without the PAYT system. The results showed that the PAYT tariff structure, while not significantly impacting recycling rates (Recycled Waste, RW) as measured by the percentage of recycled waste, did lead to a significant reduction in the tons of non-recycled waste (NRW). This suggests that PAYT may effectively encourage households to reduce overall waste generation, though its direct influence on promoting recycling practices is less apparent. The study's results indicate that while PAYT can effectively reduce non-recycled waste, its influence on recycling behaviors may be more complex. The absence of a significant effect on recycling rates might stem from a behavioral lag, where households initially respond by reducing waste generation rather than immediately increasing recycling efforts. This could suggest that PAYT's impact on recycling behavior requires a more extended adaptation period for households to fully incorporate separate waste collection into their routines. Additionally, the reduction in non-recycled waste may also reflect a broader behavioral shift toward overall waste minimization, possibly due to financial motivations inherent in the PAYT structure. The observed decrease in non-recycled waste without a corresponding rise in recycling rates may be due to the nature of PAYT as an incentive primarily against waste production rather than a direct motivator for recycling (Ukkonen & Sahimaa, 2021). Households might initially choose to minimize waste as a straightforward cost-saving measure. Over time, however, more nuanced adjustments, such as increased sorting and recycling, could emerge as households become more accustomed to the PAYT model and its financial implications (Dunne et al., 2008, Dias-Ferreira et al., 2018, Vorobeva et al., 2022).

Limitations of the Study

Several limitations might influence the interpretation of these findings. First, the dataset's demographic detail is limited, which constrains the analysis of specific group behaviors and potential variations in response to PAYT across different demographics. Second, as this study captures only the initial years following PAYT implementation, the full behavioral adjustments that may evolve over time remain unobserved. Lastly, factors external to the PAYT policy, such as environmental campaigns or regional policy changes, might have also influenced waste reduction independently, potentially confounding the impact attributed solely to PAYT. The reliance on available municipal-level data and the constraints on household-specific demographic details limit the ability to capture finer-grained behaviors that might vary across different household types or socio-economic backgrounds. Additionally, changes in the tariff structure during the study period introduced complexities in data processing, though data engineering adjustments were implemented to standardize entries for analysis.

Suggestions for Future Research

Further studies could examine the long-term effects of PAYT on recycling rates to capture delayed behavioral changes. Additionally, integrating more granular demographic data would enable a more precise analysis of PAYT's impact across different household profiles. Future research might also consider complementary policies, such as targeted recycling awareness campaigns, to assess whether such interventions enhance PAYT's effectiveness in promoting recycling alongside waste reduction.

Conclusion

This study highlights the potential of the Pay-As-You-Throw (PAYT) system as a tool for promoting sustainable waste management. By linking disposal costs directly to household behavior, PAYT shows promise in reducing non-recycled waste, suggesting an initial shift toward minimized waste generation among households. However, the findings indicate that while PAYT effectively reduces total waste, its influence on actively increasing recycling rates may take longer to manifest. For policymakers, this underlines the importance of pairing PAYT with additional strategies, such as educational initiatives, to bolster its impact on recycling. As cities and municipalities seek comprehensive solutions for waste management, PAYT emerges as a valuable component with potential for enhancing environmental responsibility, though its full impact may require ongoing adaptation and support from both households and policy frameworks

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Chapter 3: Third study

Impact evaluation of games on prosocial behaviors: a case study on “Prosperia”

Abstract

This study explores the impact of the semi-competitive boardgame “Prosperia” on prosocial behaviors, specifically focusing on cooperation and competition tendencies among 11/13-year-old middle school students in Tuscany. Using a pre-post research design, the study examines how gameplay influences students’ inclination to cooperate or compete. Through player assessments and behavioral analysis conducted before and after engaging with the game, findings reveal that “Prosperia” significantly increases cooperative behavior while slightly enhancing competitive tendencies. The study demonstrates that, despite the semi-competitive nature of the game, the entertaining and collaborative elements foster a lasting boost in cooperativeness, offering insights for educational game design in promoting prosocial attitudes.

Keywords: Behavioral Economics, Game Science, Cooperative Tendencies, Game-Based Learning

JEL codes: C93, D64, D91

Introduction

In the last decades, game-based educational programs have progressively been adopted in all fields and education levels (Fonseca et al., 2023). This study explores the impact that semi-competitive board games can have on the development of prosocial behaviors, particularly cooperation and competition, in middle school students. The relationship between gaming and prosocial behavior has been widely debated in the literature, particularly in the context of digital games (Connolly et al., 2012), but less so concerning traditional board games. Studies have shown that cooperative games can enhance social skills such as empathy, teamwork, and conflict resolution (Garaigordobil et al., 1996). However, the balance between competition and cooperation in games like “Prosperia” raises questions about how these dynamics interact. Research on younger populations, especially in school environments, is particularly limited, and the effects of semi-competitive games on cooperation and competition tendencies remain underexplored. This study addresses this gap by focusing on how board games can be used as tools to encourage prosocial behaviors in educational settings (Taspinar et al., 2016). By employing a pre-post research design, the study aims to assess how engaging with the game affects students’ social interactions and behavioral tendencies, contributing to the broader understanding of how game-based learning can be used to promote prosocial development in educational contexts (Plass et al., 2015). Additionally, the research seeks to provide insights into how semi-competitive games can be balanced to foster a positive social environment while still encouraging healthy competition.

Literature review

The study of games and their influence on social behaviors has a short history, evolving from early research on competitive sports to the growing interest in digital and tabletop games (Zizzo & Tan, 2011). In the mid-20th century, games were primarily viewed as competitive activities, often associated with fostering rivalry and aggression. However, by the late 20th century, research began to explore the potential of games to teach cooperation, especially in educational and team-based settings. Early studies on cooperative learning in classrooms demonstrated that group tasks and problem-solving activities could enhance social skills and empathy among students. In recent decades, the rise of digital and board games has opened new avenues for research on their impact on prosocial behaviors. While video games often dominate this discourse, board games have received less attention, despite their ability to blend social interaction with structured competition. Semi-competitive games, which incorporate both competitive and cooperative elements, are a more recent focus in this field. These games challenge the binary view of competition versus cooperation, offering a complex dynamic where players must balance self-interest with group success. The role

of games in educational settings has also gained prominence. Educators have increasingly used games as tools to enhance learning, not only for academic content but also for social development. Cooperative and semi-competitive games have been studied for their potential to promote prosocial behaviors in children and adolescents (Li & Tsai, 2013). This study contributes to that growing body of literature by examining how a semi-competitive board game, *Prosperia*, impacts cooperation and competition among middle school students, an age group where social skills are rapidly developing (Novian et al., 2019). Several key contributions have shaped the understanding of how games influence prosocial behaviors and social dynamics (Devilly et al., 2017). Early research in the 1970s and 1980s laid the groundwork by exploring the effects of competitive versus cooperative environments on social behavior (Atkinson et al., 2020), with findings indicating that cooperative tasks tended to foster more positive interpersonal relationships and empathy compared to competitive ones (Morschheuser et al., 2017).

In the 1990s and 2000s, research began focusing on educational games (Plass et al., 2015), particularly in classroom settings, showing that collaborative games could improve teamwork (Atkinson et al., 2020), communication, and problem-solving skills among students (Fonseca et al., 2023). This period also saw the rise of studies on game-based learning (Taspinar et al., 2016), where games were integrated into educational curricula to enhance both cognitive and social learning outcomes (Iannace et al., 2024). More recently, contributions from the field of digital game studies have examined the social impact of multiplayer and cooperative video games. Studies demonstrated that well-designed games could encourage prosocial behaviors, such as helping others and cooperation, even in virtual environments (Caroux, 2023). These findings have been extended to non-digital formats, with research on board games highlighting their role in fostering face-to-face social interactions and teaching complex social skills through structured play. A significant development in recent years has been the study of semi-competitive games, which blend elements of cooperation and competition (Haesevoets et al., 2015). These games offer a more nuanced understanding of how different game mechanics can influence players' behavior, challenging the traditional dichotomy of "competitive vs. cooperative" gameplay (Garaigordobil et al., 1996). Researchers have found that games with both collaborative and competitive aspects can encourage players to navigate social dilemmas, negotiate goals, and balance personal success with group achievement (Lu et al., 2013).

This study on *Prosperia* builds on these contributions by examining how semi-competitive games impact the prosocial development of middle school students, an age group that has been less studied

in this context. It adds to the growing body of knowledge on how games can be used as tools for promoting prosocial behaviors in educational environments.

Hypoteses

Hypothesis 1: There is a significant difference on cooperative tendencies after playing Prosperia;

Hypothesis 2: There is a significant difference on competitive tendencies after playing Prosperia;

Hypothesis 3: There is a mediation effect of one or more subdimensions of GEQ or GUESS-18 questionnaires on both cooperative and competitive tendencies changes

Methods

Partecipants

The total sample size includes 832 participants. The sample primarily consists of early adolescents, with an average age of the participants in the study being 12.12 years. The gender distribution is evenly distributed: after removing the participants with missing values, 416 males and 416 females remained for the data analysis. On average, participants have about 1.14 brothers.

Variable	Value
Total sample	832
Age (mean)	12.12 years old
Brothers (mean)	1.14 brothers or sisters
Number of males	416
Number of females	416

Figure 1: Descriptive characteristics of the sample

Materials

A mix of validated scales and novel questions were used in the study because the literature was not specific enough for the type of research hypothesis formulated.

The validated scales were:

- Cooperative and Competitive Personality Scale CCPS (Lu et al., 2013)
- GEQ (Brockmyer et al., 2009, Law et al., 2018)
- GUESS-18 (Phan et al., 2016)

The novel questions were the following:

Satisfaction in games vs. satisfaction in Prosperia	
In generale, mi piace giocare ai giochi da tavolo	Mi è piaciuto giocare a Prosperia
Mi sento sfidato in modo positivo dai giochi	Mi sono sentito sfidato in modo positivo dal gioco
Ho consigliato i giochi che ho fatto ad altri	Ho consigliato Prosperia ad altri
Sento di imparare dai giochi	Sento di aver imparato da Prosperia
Behavioral engagement: lessons vs. play	
Partecipo attivamente alle lezioni	Ho partecipato attivamente a Prosperia
Collaboro con i miei compagni di classe nei progetti e nei compiti di gruppo	Ho collaborato con i miei compagni di classe in Prosperia
Emotional engagement: games vs. Prosperia	
Sono interessato a imparare tramite i giochi	Sono interessato a imparare tramite i giochi
Sono motivato a fare bene nei giochi che faccio	Ero motivato a fare bene in Prosperia
Sento che i giochi sono personalmente rilevanti e significativi per me.	Sento che Prosperia è stato personalmente rilevante e significativo per me.
Additional questions on gaming habits	
Voglio approfondire le mie conoscenze tramite il gioco	Ho approfondito le mie conoscenze tramite Prosperia.
Di solito non rigioco i giochi da tavolo già giocati	Mi piacerebbe giocare di nuovo a Prosperia

Figure 2: New items made for specific constructs not validated in literature

These items were made new or readapted from pre-existing scales directly into Italian, while a group of experts translated validated scales to ensure that their meaning was preserved.

Game rules

The Prosperia game in this study is a treatment aimed at stimulating a change in students. The mechanics of the game are partially taken from the basic mechanics of Monopoly, while the innovative part consists of the setting and being able to choose between two different ways of winning after half a game. The two modes are individually chosen, one cooperative and the other competitive. Players who choose competitive victory mode must maximise their profit, while those who choose cooperative victory mode must maximise their level of wealth. If the overall wealth level falls below a certain threshold, everyone loses.

Procedures

The game was played in the period between April and June in several Tuscan schools participating in a prosocial project promoted by UNICOOP Firenze (a renowned Italian supermarket cooperative). The research project was linked to the project to make an impact assessment. Specialised educators acted as facilitators during the game and feedback phases. The total

classroom experience lasted three hours. The survey was administered before the game and two weeks after the game, always in the classrooms.

Analysis

Based on the research design and the questions asked, it was possible to assess the differences between the pre and post questionnaire by means of the paired t-test. In addition to this, a correlation matrix and several linear regression models were tested to identify whether enjoyment of the game mediated the change in the cooperation scale.

Results

Pre vs post

Figure 3 shows the results of the comparison between general games and specifically the game Prosperia.

Question (pre vs post)	t	p-value	cohen-d	n° subjects
DD1	-19.066	<.001	0.662	830
DD2	-2.467	0.014	0.087	812
DD3	11.376	<0.001	-0.399	812
DD4	-2.368	0.018	0.083	811
DD5	-15.266	<.001	0.534	817
DD6	0.961	0.337	-0.034	820
DD7	-3.723	<.001	0.130	821
DD8	3.123	0.002	-0.109	817
DD9	1.326	0.185	-0.046	815
DD10	3.370	0.001	-0.118	814
DD11	-0.297	0.766	0.010	821
DD12	-5.164	<0.001	0.182	806
DD13	-1.029	0.304	0.036	813
DD14	1.386	0.166	-0.048	821
DD15	-3.449	0.001	0.120	823
DD16	-2.915	0.004	0.102	820
DD17	-2.725	0.007	0.095	822
DD18	1.751	0.080	-0.061	822
DD19	-1.571	0.117	0.055	811

Figure 3. T-test for each question, investigating the impact of Prosperia. Bold = statistical significant effect.

The first section of the t-test investigates general aspects of the game Prosperia in comparison to other games. Satisfaction with Prosperia was notably higher than with general games (DD1, $t = -19.066$, $p < .001$, $d = 0.662$). Students felt slightly more challenged (DD2, $t = -2.467$, $p = .014$, $d = 0.087$) by the game in comparison to general games, and they learned more from Prosperia (DD4, $t =$

= -15.266, $p < .001$, $d = 0.534$). The only drawback in this part is the lower likelihood of talking about Prosperia to other people (DD3, $t = 11.376$, $p < .001$, $d = -0.399$).

The second theme focuses on behavioral engagement and each question compares traditional lectures with a game-based learning approach through Prosperia. The data shows a significant and positive difference in active participation when engaged with Prosperia (DD5, $t = -15.266$, $p < .001$, $d = 0.534$), while a not significant difference regarding class group collaboration (DD6, $t = 0.961$, $p = .337$, $d = -0.034$). These results suggest that while “Prosperia” can improve individual aspects of behavioral engagement, such as active participation, it may not significantly affect collective ones, like collaboration in group tasks.

The third section focuses on interest and motivation, yielding mixed results. Prosperia seems to have a higher impact on learning interest through the game (DD7 $t = -3.723$, $p < .001$, $d = 0.130$), while the motivation to perform well in Prosperia was lower in comparison to other games (DD8, $t = 3.123$, $p = .002$, $d = -0.109$). Personal significance and relevance of games did not significantly change before and after the experience (DD9, $t = 1.326$, $p = .185$, $d = -0.046$).

Moreover, students deepened their knowledge through games more than their willingness (DD10, $t = 3.370$, $p = .001$, $d = -0.118$), while the willingness to play again the game did not differ significantly from general games (DD11, $t = -1.029$, $p = .304$, $d = 0.036$).

Questions from 12 to 19 compose a battery regarding cooperation and competitiveness behaviors in games. Also in this case, mixed results have been found. After the game, students are more likely to consider others' interests (DD12, $t = -5.164$, $p < .001$, $d = 0.182$), but they are also more likely to outdo others (DD15, $t = -3.449$, $p = .001$, $d = 0.120$), have higher self-esteem while outdoing others (DD16, $t = -2.915$, $p = .004$, $d = 0.102$), and see evaluations as an opportunity to prove themselves smarter (DD17, $t = -2.725$, $p = .007$, $d = 0.095$). Working with others to reach a common goal did not have a significant impact (DD18, $t = 1.751$, $p = .080$, $d = -0.061$), and also there were no significant differences in getting in the shoes of others (DD13, $t = -1.029$, $p = .304$, $d = 0.036$), listening to others' opinions (DD14, $t = 1.386$, $p = .166$, $d = -0.048$), and being bothered by others outdoing you (DD19, $t = -1.571$, $p = .117$, $d = 0.055$).

Age and gender effects

The ANOVA test for age and the t-test to check the effect of gender showed little impact of these two factors. The difference in attitudes before and after playing the game was significant only for a few questions and always with a low size effect.

Question (pre vs post)	p-value (age)	R-squared
DD1	0.129	0.007
DD2	0.948	<0.001
DD3	0.076	0.009
DD4	0.006	0.015
DD5	0.836	0.001
DD6	0.855	0.001
DD7	0.105	0.008
DD8	0.279	0.005
DD9	0.001	0.021
DD10	0.142	0.007
DD11	0.040	0.010
DD12	0.396	0.004
DD13	0.003	0.018
DD14	0.863	0.001
DD15	0.136	0.007
DD16	0.441	0.003
DD17	0.484	0.003
DD18	0.337	0.004
DD19	0.720	0.002

Figure 4. ANOVA test for each question, conditional on participants' age. Bold = statistical significant effect.

Regarding age effect, p-values are under .05 only for the following questions: DD4, DD9, DD11 and DD13. In *Learning from Games* (DD4), there is a significant age effect on it ($p < .01$), with an R-squared value of 0.015. This indicates that age accounts for approximately 1.5% of the variance in the difference between pre- and post-test responses regarding the impact of Prosperia in learning, in comparison to general games. About *Personal Game Relevance and Significance* (DD9), the ANOVA results show a significant effect of age on the perceived relevance and significance of the game ($p < .001$), with an R-squared value of 0.0208. This means that age explains about 2.1% of the variance in how students' perceptions of the game's relevance differ in Prosperia vs other general games. Also, variance explained for *Willingness to Play Again* (DD11, $p < .05$, $r^2 = .01$) and *Getting in Others' Shoes* (DD13, $p < .005$, $r^2 = .018$) have a significant effect but a very small explanatory value.

Question (pre vs post)	p-value	t-statistic	cohen's d
DD1	0.001	3.337	0.233
DD2	<0.001	-4.739	-0.334
DD3	0.084	1.729	0.122
DD4	0.093	-1.68	-0.119
DD5	0.062	1.868	0.131
DD6	0.015	2.444	0.172
DD7	0.629	0.483	0.034
DD8	0.153	-1.431	-0.101
DD9	0.001	-3.389	-0.239
DD10	0.361	-0.915	-0.064
DD11	0.337	0.960	0.067
DD12	0.240	1.176	0.083
DD13	0.377	-0.884	-0.062
DD14	0.024	2.268	0.159
DD15	0.771	-0.291	-0.02
DD16	0.259	-1.130	-0.079
DD17	0.632	0.479	0.034
DD18	0.772	0.289	0.020
DD19	0.807	0.244	0.017

Figure 5. T-test for each question, conditional on participants' gender. Bold = statistical significant effect.

The t-test results for gender also indicate some differences between males and females in their responses, but with size effects that are small for every statistically significant observation.

Gender differences were significant for five questions in this category. For females the difference between the feeling of being challenged in Prosperia rather than in general games was greater than in males (DD2, $p < .001$, $d = -.33$) and they also reported higher levels of the game's personal significance and relevance in comparison to general games (DD9, $p < .001$, $d = -.023$). Males instead liked more Prosperia than general games to a greater extent than females (DD1, $p < .001$, $d = .023$), they felt more group collaboration (DD6, $p < .05$, $d = .017$) and listened more to other opinions when disagreeing while playing in Prosperia in comparison to general games (DD14, $p < .001$, $d = .15$).

In-game Experience

To assess the impact of the in-game experience were made multiple linear regressions between the two psychological scales (GEQ and GUESS-18) and the difference pre vs post of the first 19 questions regarding games and competitive/cooperative behaviors. This allows us to have a deeper understanding of which aspects of the game play a major role.

Both GEQ and GUESS have been tested on two levels:

- An OLS between the overall mean of the scale as a predictor and the difference between pre and post as the dependent variable.
- An OLS considering all dimensions of the scales as predictors and the difference between pre and post as the dependent variable.

Finally, an all-comprehensive OLS taking into account all factors of both the GEQ and the GUESS scales has been conducted. The results are shown in the next sections. Overall, GEQ performs better in predicting the difference between the survey pre-experience and the one post-game experience, and considering both scales adds little value to the total variance explained.

GEQ

Question (pre vs post)	p-value	R-squared
DD1	<0.001	0.057
DD2	<0.001	0.043
DD3	0.001	0.015
DD4	<0.001	0.056
DD5	<0.001	0.095
DD6	<0.001	0.024
DD7	<0.001	0.067
DD8	<0.001	0.074
DD9	<0.001	0.083
DD10	<0.001	0.046
DD11	<0.001	0.148
DD12	<0.001	0.044
DD13	<0.001	0.024
DD14	<0.001	0.020
DD15	0.260	0.002
DD16	0.004	0.011
DD17	0.067	0.005
DD18	<0.001	0.021
DD19	0.018	0.008

Figure 6. OLS between GEQ mean and the difference (pre vs post) for each question

In the case of GEQ, the OLS regression using the overall GEQ mean (Figure 6) as the predictor generally shows statistically significant p-values across all dependent variables but DD15 and DD17; though the R-squared values are relatively low. Only one question out of the 19 has over 10% of its variance explained by the GEQ mean. In order to facilitate the results reading, it is possible to divide them into three different group of results, according to the portion of variance explained:

- **Under 5%:** DD3 ($R^2 = 0.015$), DD13 ($R^2 = 0.024$), DD14 ($R^2 = 0.020$), DD16 ($R^2 = -0.011$), DD19 ($R^2 = 0.008$).
- **Between 5% and 10%:** DDD1 ($R^2 = 0.057$), DD2 ($R^2 = 0.043$), DD4 ($R^2 = 0.056$), DD5 ($R^2 = 0.095$), DD6 ($R^2 = 0.024$), DD7 ($R^2 = 0.067$), DD8 ($R^2 = 0.074$), DD9 ($R^2 = 0.083$), DD10 ($R^2 = 0.046$), DD12 ($R^2 = 0.044$), DD18 ($R^2 = 0.021$).
- **Over 10%:** DD11 ($R^2 = 0.148$).

Considering all dimensions of the scale, it is possible to explain a greater portion of the variance. As in Figure 7, every value of the coefficient of determination is higher after performing this new approach. The majority of the variances explained are now doubled or more. Now 8 questions of the 19 have at least 10% of their variance explained by the regressors. This is a big improvement over the previous explanatory power.

Question (pre vs post)	N° var.	sign.	R-squared	Question (pre vs post)	N° var.	sign.	R-squared
DD1	3		0.136	DD11	3		0.212
DD2	2		0.104	DD12	3		0.059
DD3	2		0.053	DD13	1		0.032
DD4	4		0.144	DD14	2		0.033
DD5	6		0.177	DD15	1		0.030
DD6	2		0.055	DD16	2		0.030
DD7	3		0.099	DD17	2		0.020
DD8	3		0.135	DD18	2		0.040
DD9	3		0.185	DD19	0		0.014
DD10	2		0.088				

Figure 7. OLS between GEQ dimensions means and the difference (pre vs post) for each question; the middle columns represents the number of significant predictors for the OLS

Though, a not so good result is also clear: the battery of questions from DD12 to DD19, which represents the cooperative or competitive behavior difference after playing the game, is explained very minimally by the in-game experience assessed through GEQ. This is also true for the GUESS-18 scale.

GUESS

In order to calculate the predictive power of the GUESS-18 scale for behavioral changes, it's necessary to proceed in the same way as already described: performing an OLS analysis using as a predictor the general mean of the scale, and then using all dimensions of the scale as OLS predictors.

Question (pre vs post)	p-value (guess)	R-squared	Question (pre vs post)	p-value (guess)	R-squared
DD1	<0.001	0.078	DD11	<0.001	0.159
DD2	<0.001	0.072	DD12	<0.001	0.036
DD3	<0.001	0.049	DD13	<0.001	0.031
DD4	<0.001	0.076	DD14	<0.001	0.030
DD5	<0.001	0.067	DD15	0.292	0.001
DD6	<0.001	0.020	DD16	0.234	0.002
DD7	<0.001	0.061	DD17	0.282	0.002
DD8	<0.001	0.085	DD18	<0.001	0.023
DD9	<0.001	0.112	DD19	0.062	0.005
DD10	<0.001	0.056			

Figure 8. OLS between GUESS mean and the difference (pre vs post) for each question

Results are similar to the previous section, with all dimensions adding a lot of variance explained. All results for the OLS regarding the simple GUESS-18 mean are shown in Figure 8, while the OLS considering all dimensions as predictors are shown in Figure 9. It is possible to group here as well the first results into three different clusters according to the percentage of the variance explained:

- **Under 5%:** DD14 ($R^2 = 0.030$), DD15 ($R^2 = 0.001$), DD16 ($R^2 = 0.002$), DD17 ($R^2 = 0.002$), DD19 ($R^2 = 0.005$).
- **Between 5% and 10% ($0.05 \leq R^2 < 0.10$):** DD1 ($R^2 = 0.078$), DD2 ($R^2 = 0.072$), DD3 ($R^2 = 0.049$), DD4 ($R^2 = 0.076$), DD5 ($R^2 = 0.067$), DD6 ($R^2 = 0.020$), DD7 ($R^2 = 0.061$), DD8 ($R^2 = 0.085$), DD10 ($R^2 = 0.056$), DD12 ($R^2 = 0.036$), DD13 ($R^2 = 0.031$), DD18 ($R^2 = 0.023$).
- **Over 10% ($R^2 \geq 0.10$):** DD9 ($R^2 = 0.112$), DD11 ($R^2 = 0.159$).

In this case, the scale GUESS-18 performs better than GEQ in the first 4 questions and for DD8, DD9, DD13 and DD14; for the other questions it performs worse or equal. There is also a higher number of non-significant results (4 vs 2).

When using all dimensions as predictors, something similar happens but to a lesser extent: all coefficients are increased, though only in a few cases it's possible to see a big improvement as much as in GEQ dimensions. In this case, questions with their variance explained over 10% from the psychological scales are only 5 (vs 8 of the GEQ). All values can be seen in Figure 9.

One important common point occurred between these 4 analyses: a good amount of variance can be explained by the dimensions of each scale regarding game related preference of Prosperia in comparison to all other games (from DD1 to DD11), while little or almost no variance is explained for cooperative and competitive changes after the experience.

Moreover, between GEQ and GUESS-18, the first scale shows better results: the mean of variance explained is 8.6% in comparison to 6.8%. Moreover, if it's not considered the competitive/cooperative scale, the gap is extended: GEQ explains on average 12.6% for items from DD1 to DD11, while GUESS-18 explains only 9.7%.

Question (pre vs post)	N° sign. var.	R-Squared	Question (pre vs post)	N° sign. var.	R-Squared
DD1	3	0.104	DD11	4	0.175
DD2	2	0.088	DD12	3	0.049
DD3	2	0.060	DD13	3	0.043
DD4	3	0.110	DD14	2	0.042
DD5	2	0.099	DD15	2	0.025
DD6	1	0.027	DD16	0	0.010
DD7	2	0.073	DD17	0	0.009
DD8	3	0.109	DD18	2	0.028
DD9	3	0.144	DD19	1	0.021
DD10	3	0.076			

Figure 9. OLS between GEQ dimensions means and the difference (pre vs post) for each question; the middle columns represents the number of significant predictors for the OLS

Combination of GEQ and GUESS-18

Question (pre vs post)	n° of sign. var.	R-squared	Question (pre vs post)	n° of sign. var.	R-squared
DD1	3	0.145	DD11	3	0.220
DD2	3	0.114	DD12	3	0.069
DD3	2	0.071	DD13	2	0.045
DD4	4	0.152	DD14	4	0.053
DD5	7	0.194	DD15	3	0.062
DD6	3	0.064	DD16	3	0.048
DD7	4	0.104	DD17	4	0.031
DD8	5	0.145	DD18	2	0.052
DD9	6	0.187	DD19	0	0.029
DD10	4	0.113			

Figure 10. OLS between GEQ and GUESS-18 dimensions and the difference (pre vs post) for each question; the middle columns represent the number of significant predictors for the OLS

In the last analysis, was performed an OLS with all dimensions of both GEQ and GUESS-18 scales. The results can be seen in Figure 10.

Very little variance has been added from the OLS considering only GEQ dimensions. On average, for all items, the combination of both scales adds on average 1.5% of explained variance for all questions, and 1.8% of variance for questions from D12 to D19.

Data clearly shows that it might be sufficient to use only GEQ in order to assess the impact of game related experience. Though, in order to capture the impact on cooperative and competitive behavior, administering both scales almost doubles the explained variance.

Single in-game predictors

Finally, was also tried predicting single question changes with the mean of all dimensions of both GEQ and GUESS-18 scales, trying to get a grasp on what aspects of the game have the highest impact on behavioral change and the relative preference for Prosperia in comparison to general games.

A threshold of variance explained was set in order to capture only the most influential aspects, setting this value to 10%, or $r\text{-squared}=0.1$. No single dimensions predicted any cooperative or competitive behavioral change: in fact, as it's possible to see in Figure 11 for a summary of results, no questions from DD12 to DD19 have been included.

On the other hand, the question 9, about personal relevance and significance is strongly predicted by GUESS-18 "Narrative", "Enjoyment", "Immersion" dimensions and by GEQ "Positive Affect" dimension. Also, "Positive Affect" dimension of GEQ predicts many attitudes in favor of Prosperia in comparison to other games, demonstrating to be a . All results are shown in Figure 11.

X	Y	Coef	Intercept	P-value	R-squared
Narrative	DD9	0.48	-2.532	<0.001	0.104
Enjoyment	DD9	0.488	-2.812	<0.001	0.106
Immersion	DD4	0.557	-2.548	<0.001	0.110
Immersion	DD9	0.643	-3.276	<0.001	0.164
Positive Affect	DD1	0.466	-1.373	<0.001	0.111
Positive Affect	DD5	0.461	-1.621	<0.001	0.114
Positive Affect	DD8	0.453	-2.728	<0.001	0.100
Positive Affect	DD9	0.550	-3.150	<0.001	0.118
GUESS	DD9	0.711	-3.647	<0.001	0.113

Figure 11. OLS between single dimensions of GEQ and GUESS-18 scales and pre vs post differences. Only observations with an $r\text{-squared}$ higher than 0.1 have been kept. DD11 has been excluded for reliability reasons.

Discussion/conclusion

In recent decades, game-based educational programs have progressively been adopted in all fields and education levels (Connolly et al., 2012, Fonseca et al., 2023). This article explores the impact of semi-competitive board game “Prosperia” on the development of prosocial behaviors. The board game Prosperia has demonstrated to have been a positive experience for the students, who liked and participated in the game to a much greater extent in comparison to normal games. Also, students felt slightly more challenged by it than from general games. Though they are less likely to talk about it to other people. Regarding school activities comparison, students are more likely to be interested in learning through the game than through normal lectures, and they also slightly feel they learn more from it. The game also had an impact in enhancing cooperative behaviors among participants: after the game, students were much more likely to consider others’ interests when having a task to complete. Playing the game also slightly increased some competitive behaviors like the willingness to do better than others in a group, even if in a smaller way. Overall, Prosperia had a good impact on cooperative behavior among participants. Age had very little impact on the effects of the game on all considered aspects, explaining no more than 2.1% and being significant for only three items. Gender differences instead were more pronounced. Females felt Prosperia to be more challenging than general games in comparison to males, and they also felt it more relevant and significant. Males on the other hand liked it more in comparison to other general games. Regarding the in-game experiences, results are pretty clear in favoring the GEQ as predictor of game preference over general games, where it explains more variance than GUESS-18 in 16 out of 19 questions. Though, when trying to predict competitive or cooperative behavioral change after the game, neither scale can explain more than 6%, indicating a poor overall performance. The merging of the two scales adds little explanation in addition to GEQ, indicating that GEQ alone could be enough for assessment of this activity.

The study’s findings support the first hypothesis, as the game “Prosperia” led to a significant increase in cooperative behaviors among the students. The game’s mechanics, which encourage shared goals and group problem-solving, likely fostered an environment where students felt motivated to work collaboratively. This is evidenced by the observed rise in behaviors such as considering others’ interests in completing tasks, suggesting that students internalized the game’s cooperative aspects. The second hypothesis, which posited that competitive elements would also increase competitive behaviors, was similarly supported. Despite Prosperia’s focus on collaboration, elements of the game that rewarded individual achievements appeared to encourage a slightly increase in competitive attitudes, like the desire to perform better than others. These

findings indicate that a semi-competitive structure in games can balance cooperative and competitive drives, supporting prosocial development by fostering both group-oriented and self-oriented goals. The third hypothesis is also positively supported by results, in which it is possible to find a moderator effect of some subdimensions on cooperative tendencies.

The impact of “Prosperia” on both cooperation and mild competition might stem from its unique blend of shared and individual objectives. By allowing players to choose between cooperative and competitive victory modes, the game provides a dual reinforcement of both personal and collective goals. Students who engaged more with the cooperative elements likely experienced positive reinforcement in collaborative behaviors, while the structured competitiveness allowed students to pursue self-improvement in a controlled and socially acceptable way. This mixed structure may have helped students navigate social dilemmas, fostering both empathy and ambition in a balanced manner.

Limitations of the study

Several limitations may have influenced the outcomes of this study. First, the lack of a control group limits our ability to attribute changes in prosocial behavior solely to Prosperia, as other external factors could have played a role. Additionally, due to class size constraints, some students played in pairs rather than individually, creating a shared experience that may have diluted individual impacts. Another limitation was the absence of data on the players’ choice between cooperative and competitive victory modes, which could have provided further insights into how different motivations impact prosocial development. Finally, the reliance on self-reported data for behavioral changes may introduce bias, as students’ perceptions may not fully align with their actual behaviors.

Future research could address these limitations by incorporating a control group to better isolate the effect of the game. Studies could also analyze the outcomes based on students’ chosen victory modes to examine how specific game strategies influence cooperative and competitive behaviors. Additionally, conducting similar studies across different age groups or using diverse cultural contexts would help generalize findings and explore developmental differences in response to game-based learning. Implementing observational methods alongside self-reported data could provide a more comprehensive picture of behavioral changes.

Conclusion

The findings from this study illustrate that the semi-competitive board game “Prosperia” effectively enhances prosocial behaviors, particularly cooperation, among middle school students. By blending

collaborative and competitive elements, “Prosperia” fosters a dynamic learning environment where students can develop empathy and teamwork skills while also navigating healthy competition. Although some competitive behaviors increased slightly, the game primarily strengthened cooperative tendencies, underscoring its potential as a tool for social development in educational settings. These results suggest that incorporating semi-competitive games into school curricula could be a valuable approach to promoting balanced prosocial skills, preparing students to engage constructively with both collaborative and individual challenges.

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Appendix

Pre	Post
Soddisfazione nei giochi vs soddisfazione in Prosperia	
In generale, mi piace giocare ai giochi da tavolo	Mi è piaciuto giocare a Prosperia
Mi sento sfidato in modo positivo dai giochi	Mi sono sentito sfidato in modo positivo dal gioco
Ho consigliato i giochi che ho fatto ad altri	Ho consigliato Prosperia ad altri
Sento di imparare dai giochi	Sento di aver imparato da Prosperia
Engagement comportamentale: lezioni vs gioco	
Partecipo attivamente alle lezioni	Ho partecipato attivamente a Prosperia
Collaboro con i miei compagni di classe nei progetti e nei compiti di gruppo	Ho collaborato con i miei compagni di classe in Prosperia
Engagement emotivo: giochi vs Prosperia	
Sono interessato a imparare tramite i giochi	Sono interessato a imparare tramite i giochi
Sono motivato a fare bene nei giochi che faccio	Ero motivato a fare bene in Prosperia
Sento che i giochi sono personalmente rilevanti e significativi per me.	Sento che Prosperia è stato personalmente rilevante e significativo per me.
Domande aggiuntive su abitudini di gioco	
Voglio approfondire le mie conoscenze tramite il gioco	Ho approfondito le mie conoscenze tramite Prosperia.
Di solito non rigioco i giochi da tavolo già giocati	Mi piacerebbe giocare di nuovo a Prosperia
Tendenza alla cooperazione vs Tendenza alla competizione	
Nello svolgere un compito sono solito considerare gli interessi degli altri	Nello svolgere un compito sono solito considerare gli interessi degli altri
Di solito, riesco a mettermi nei panni degli altri membri del gruppo per considerare i loro interessi.	Di solito, riesco a mettermi nei panni degli altri membri del gruppo per considerare i loro interessi.
Quando collaboro con i membri di un gruppo, sono spesso disposto ad ascoltare le opinioni degli altri, anche se non sono d'accordo	Quando collaboro con i membri di un gruppo, sono spesso disposto ad ascoltare le opinioni degli altri, anche se non sono d'accordo
Anche in un gruppo che lavora per un obiettivo comune, voglio superare gli altri	Anche in un gruppo che lavora per un obiettivo comune, voglio superare gli altri
La mia autostima può migliorare solo se supero gli altri nel gruppo	La mia autostima può migliorare solo se supero gli altri nel gruppo
A volte considero le valutazioni come un'opportunità per dimostrare che sono più intelligente degli altri	A volte considero le valutazioni come un'opportunità per dimostrare che sono più intelligente degli altri
Mi piace lavorare con gli altri membri del gruppo per raggiungere un successo comune.	Mi piace lavorare con gli altri membri del gruppo per raggiungere un successo comune.
Essere superato da altri membri del gruppo mi infastidisce	Essere superato da altri membri del gruppo mi infastidisce

GUESS-18 Constructs and Statements	
Usability/Playability (English)	Usabilità/Giocabilità (Italian Translation)
S1: I find the controls of the game to be straightforward.	S1: Trovo le regole del gioco intuitive.
S2: I find the game's interface to be easy to navigate.	S2: La plancia del gioco mi sembra facile da leggere.
Narratives	
Narrativa	
S1: I am captivated by the game's story from the beginning.	S1: Sono affascinato/a dall'ambientazione del gioco fin dall'inizio.
S2: I enjoy the fantasy or story provided by the game.	S2: Mi piace la fantasia o la storia proposta dal gioco.
Play Engrossment	
Coinvolgimento nel Gioco	
S1: I feel detached from the outside world while playing the game.	S1: Mi sento distante dal mondo esterno mentre gioco.
S2: I do not care to check events that are happening in the real world during the game.	S2: Non mi interessa controllare gli eventi che stanno accadendo nel mondo reale durante il gioco.
Enjoyment	
Divertimento	
S1: I think the game is fun.	S1: Penso che il gioco sia divertente.
S2: I feel bored while playing the game.	S2: Mi annoio mentre gioco al gioco.
Creative Freedom	
Libertà Creativa	
S1: I feel the game allows me to be imaginative.	S1: Sento che il gioco mi permette di essere creativo.
S2: I feel creative while playing the game.	S2: Mi sento creativo/a mentre gioco al gioco.

Personal Gratification	Soddisfazione Personale
S1: I am very focused on my own performance while playing the game.	S1: Sono molto concentrato/a sulle mie prestazioni mentre gioco.
S2: I want to do as well as possible during the game.	S2: Voglio fare del mio meglio durante il gioco.
Social Connectivity	Connettività Sociale
S1: I find the game supports social interaction (e.g., chat) between players.	S1: Trovo che il gioco supporti l'interazione sociale tra i giocatori.
S2: I like to play this game with other players.	S2: Mi piace giocare a questo gioco con altri giocatori.
Visual Aesthetics	Estetica Visiva
S1: I enjoy the game's graphics.	S1: Mi piace la grafica del gioco.
S2: I think the game is visually appealing.	S2: Penso che il gioco sia visivamente attraente.

Item	Construct	Domanda	Indicatore
I was good at it	Competence	Ero bravo nel gioco	Competenza
I felt skillful	Competence	Mi sentivo abile	Competenza
I felt successful	Competence	Mi sentivo vincente	Competenza
I was fast at reaching the game's targets	Competence	Ero veloce nel capire gli obiettivi del gioco	Competenza
I felt competent	Competence	Mi sentivo competente	Competenza
I felt that I could explore things	Immersion	Avevo la sensazione di stare esplorando	Immersività
I was interested in the game's story	Immersion	Ero interessato/a al messaggio del gioco	Immersività
I felt imaginative	Immersion	Mi sentivo vivace	Immersività
I found it impressive	Immersion	Lo trovavo sorprendente	Immersività
It felt like a rich experience	Immersion	L'ho sentita una bella esperienza	Immersività
It was aesthetically pleasing	Immersion	Era esteticamente bello	Immersività
I lost connection with the outside world	Flow	Ho perso il contatto con il mondo esterno	Flusso
I forgot everything around me	Flow	Ho dimenticato tutto intorno a me	Flusso
I lost track of time	Flow	Ho perso la percezione del tempo	Flusso
I was fully occupied with the game	Flow	Ero completamente occupato/a con il gioco	Flusso
I was deeply concentrated in the game	Flow	Ero profondamente concentrato/a nel gioco	Flusso
I felt irritable	Tension	Mi sentivo irritabile	Tensione
I felt annoyed	Tension	Mi sentivo infastidito/a	Tensione
I felt frustrated	Tension	Mi sentivo frustrato/a	Tensione
I felt pressured	Tension	Mi sentivo sotto pressione	Tensione
I felt time pressure	Challenge	Avevo la sensazione di dover fare tutto in fretta	Sfida
I thought it was hard	Challenge	Pensavo che fosse difficile	Sfida
I felt challenged	Challenge	Mi sentivo sfidato/a	Sfida
I had to put a lot of effort in to it	Challenge	Ci ho messo molto impegno	Sfida
It gave me a bad mood	Negative Affect	Mi ha messo di cattivo umore	Affetto Negativo
I found it tiresome	Negative Affect	Lo trovavo faticoso	Affetto Negativo
I felt bored	Negative Affect	Mi sentivo annoiato/a	Affetto Negativo
I thought about other things	Negative Affect	Pensavo ad altre cose	Affetto Negativo
I felt happy	Positive Affect	Mi sentivo felice	Affetto Positivo
I thought it was fun	Positive Affect	Mi sono divertito	Affetto Positivo
I enjoyed it	Positive Affect	Mi è piaciuto	Affetto Positivo
I felt good	Positive Affect	Mi sentivo bene	Affetto Positivo
I felt content	Positive Affect	Mi sentivo soddisfatto/a	Affetto Positivo

Final Discussion and Conclusion

This thesis explores how diverse behavioral strategies (social norms, economic incentives, and gamification) can elicit pro-social and pro-environmental behaviors. The three studies presented underscore the importance of multifaceted interventions for promoting positive behavioral change, each offering unique insights into the mechanisms by which these changes can be encouraged. As highlighted in the introduction, models like COM-B, TDF, and BCW emphasize the dynamic interaction between capability, opportunity, and motivation in effecting behavioral change. Each study within this thesis should be included as a factor in them through different mechanisms that align individual behaviors with broader social and environmental goals in cultural heritage.

Study 1: Social Norms and Waste Management

The first study examined how social norms, such as trending, static, and top norms, impact individuals' waste management behaviors. These norms served as motivational tools, leveraging individuals' desire for social conformity to encourage recycling. Findings revealed that norms can influence recycling intentions, particularly among male participants. The illusion of knowledge—where individuals overestimate their understanding of correct waste-sorting practices—and strategic ignorance were also found to hinder effective recycling behaviors. These insights suggest that while social norms can effectively motivate pro-environmental actions, addressing knowledge biases and encouraging informational engagement are essential for maximizing the impact of norm-based interventions.

Study 2: Economic Incentives and the Pay-As-You-Throw (PAYT) System

The second study assessed the impact of the PAYT system, an economic incentive designed to reduce waste generation by linking disposal costs to waste production. Through a Difference-in-Differences approach, the research found that PAYT successfully decreased the volume of non-recycled waste in treated municipalities, supporting the role of financial mechanisms as effective behavior-change tools. While PAYT's influence on recycling rates was less pronounced initially, the system appears to prompt a progressive shift towards sustainable waste management practices as individuals adapt to its financial implications. This study illustrates how carefully crafted financial incentives can create opportunities for behavior change by aligning individual and environmental interests.

Study 3: Gamification and Prosocial Behavior through “Prosperia”

The final study investigated the effects of gamification on prosocial behaviors using the board game “Prosperia.” Gamification, by providing a structured yet enjoyable framework for engaging with

prosocial concepts, significantly increased cooperative behaviors post-intervention. The study observed heightened engagement and positive emotional responses among participants, highlighting gamification's potential to foster intrinsic motivation and provide a constructive learning environment. Notably, while age had minimal impact on engagement, female participants found the game more challenging, suggesting that individual experiences of gamified learning tools may vary across demographics. These findings underscore the potential of gamified interventions in educational settings to promote cooperation, empathy, and collective problem-solving.

Comparative Analysis of the Three Studies' Findings

The three studies presented in this thesis each explore distinct mechanisms for encouraging pro-social and pro-environmental behaviors: social norms, economic incentives, and gamification. Although each approach engages different aspects of behavioral influence (social conformity, financial motivation, and interactive learning) the studies reveal valuable contrasts and overlaps in their effectiveness, limitations, and implications. Both social norms and economic incentives were effective in promoting pro-environmental behaviors, yet they achieved this through different psychological pathways. Social norms influenced behaviors by appealing to individuals' desire for social approval, a mechanism particularly potent among male participants in the study on waste management. This influence was moderated by cognitive factors like the illusion of knowledge, which, if unaddressed, limited the effectiveness of norm-based interventions. Economic incentives, as tested in the PAYT system, targeted individual financial motives directly, creating a more concrete and immediate impact on waste reduction. PAYT's straightforward link between financial cost and waste generation was compelling, even in populations that might be less influenced by social conformity. Unlike social norms, PAYT exhibited a delayed effect on recycling behaviors specifically, suggesting that financial incentives are initially more effective for curbing waste volume than encouraging nuanced waste separation. Thus, while social norms appeal to collective expectations, PAYT appeals to personal financial interests, providing complementary avenues for motivating environmental behaviors. Gamification, as explored through the "Prosperia" game, demonstrated a unique approach to fostering prosocial behaviors by creating an engaging, interactive experience that differed significantly from the direct approaches of social norms and PAYT. Unlike social norms, which operate passively through societal expectations, and PAYT, which is transactional, gamification actively engages participants, enhancing intrinsic motivation and emotional connection to the behavior. The game encouraged cooperative behaviors and fostered prosocial inclinations, evidenced by participants' increased willingness to engage with collective problem-solving. Notably, this effect was observed across age groups, though it varied by gender, with female participants reporting higher levels of challenge and personal relevance. This suggests

that gamified interventions may be particularly effective in contexts where engagement and emotional buy-in are essential, making them an ideal supplement to other interventions focused on measurable behaviors like waste sorting or recycling.

The three studies reveal differing potential for sustained behavioral change. Social norms can instill habitual behaviors if reinforced over time, as individuals adapt to socially acceptable practices. However, this mechanism's effectiveness may wane without continued reinforcement, particularly if cognitive biases like the illusion of knowledge remain unaddressed. PAYT, while initially effective, may require ongoing adjustments to maintain engagement and prevent habituation, as the novelty of the economic incentive may diminish over time. Gamification offers a promising avenue for sustained engagement, as it builds on intrinsic motivation and personal challenge rather than external pressures. However, the long-term effectiveness of gamified approaches in real-world contexts remains an area for further research, particularly in understanding if and how players continue prosocial behaviors beyond the structured game environment. The studies collectively underscore the value of integrating multiple mechanisms for more comprehensive behavior change strategies. Social norms, economic incentives, and gamification each address different motivators—social conformity, personal gain, and engagement—offering complementary strengths. For instance, combining social norms with gamification could enhance both awareness and engagement in pro-environmental behaviors, potentially overcoming the knowledge gaps observed in the social norms study. PAYT could benefit from elements of gamification, such as achievement tracking or rewards, to maintain user interest over time. Together, these approaches provide a well-rounded toolkit for policymakers and practitioners aiming to foster sustained behavior change across diverse populations. While each mechanism has unique advantages and limitations, their combined use can create a more comprehensive and lasting impact on behavior. Social norms establish the behavioral framework, economic incentives provide motivation to comply with it, and gamification engages individuals emotionally and cognitively, helping to sustain commitment over time. This comparative analysis emphasizes that effective behavioral interventions benefit from targeting multiple motivational pathways, allowing for adaptive strategies that address the varying needs and preferences within diverse communities.

Implications and Future Research Directions

Each study brings to light specific mechanisms and potential interventions that address unique aspects of behavior change. However, limitations such as sample representativeness, reliance on self-reported data, and the exploratory nature of the studies point to future research opportunities. Investigating these interventions in a broader and more diverse population could provide further

insights into the generalizability and scalability of these strategies. Moreover, combining social norms with informational campaigns or linking gamified interventions with long-term impact studies could enhance understanding of their effectiveness over time.

In conclusion, this thesis contributes to the literature on behavioral economics and pro-social interventions by showing how tailored approaches (whether social, economic, or psychological) can address complex societal issues such as waste management and prosocial engagement. These findings advocate for multifaceted strategies that integrate motivational, cognitive, and opportunity-based elements to create meaningful and sustainable behavioral change as a cultural heritage.